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ANNALS *of* SURGERY

VOL. LXVII MARCH, 1918 No. 3

THE EFFECT OF TRAUMA UPON THE LARYNGEAL NERVES

AN EXPERIMENTAL STUDY

BY E. S. JUDD, M.D., G. B. NEW, M.D., AND F. C. MANN, M.D.
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FROM time to time, a complete or partial paralysis of the vocal cords is seen following thyroidectomy. The purpose of this research was to determine if possible the cause of such paralysis. It was believed that the best method by which to attempt to solve the problem would be to study the effect of traumatic procedures on the recurrent laryngeal nerves in dogs.

The method of experimentation consisted in traumatizing the laryngeal nerves in a manner similar to that which could occur in an operation and subsequently to study the function of the vocal cords. The results of these traumatic procedures can only be applied specifically to the recurrent laryngeal nerves, for the results may not be the same for other nerves of a different size or in a different location.

All operations were done under ether anæsthesia, employing sterile technic. The various operations differed only in regard to the traumatic procedure used. On the day following the operation the function of the cords was observed. These observations were subsequently made as frequently and over as long a time as seemed necessary in each individual experiment.

The function of the vocal cords was observed by direct laryngoscopy without an anæsthetic. It is impossible to get the animal voluntarily to approximate the cords as may be done in the human being, but their action was readily observed when the dog attempted to make a noise. In observing complete bilateral cord paralysis in the dog, inspiration frequently causes approximation, but this is easily differentiated from a functionating cord. To make the observation free from all personal bias the observer made notes of the result of his examination without knowledge of the operation performed or the results of his previous observations.

Injury to the recurrent laryngeal nerves produces some general effects which should be noted. The severity of these effects depends on whether one or both nerves are injured and also the anatomic site of injury. Owing to the fact that the laryngeal nerve gives off branches to the trachea and œsophagus, the results of injury are greater when these branches are also involved, *i.e.*, when the point of injury is at a considerable distance from the larynx. Usually when only one nerve is involved, the general results are not marked.

Complete destruction of the function of both recurrent laryngeal nerves

at a point below the lower poles of the thyroid of the dog, results in some inability of the animal to swallow properly, a total loss of voice, and sometimes dyspnœa. In most cases very little effect on the ability of the animal to swallow was noted. The voice was always lost, although in many instances the animal was able to produce various sounds. Many of the animals suffered from dyspnœa continuously, while most of the others could be made dyspnœic from exertion. This result which differs from that observed in the human being is probably due to the fact that the paralyzed cords tend to fall inward on inspiration in the dog and to form pockets laterally. This acts like a valve and in extreme cases the air will be completely shut off. The faster and harder the animal attempts to breathe the greater the difficulty of passing air into the trachea. Many of the dogs could not exert themselves in the least without inducing the greatest dyspnœa and in some cases cyanosis.

The effect of pinching was studied. The nerves were picked up at various points of their course and pinched once with a hæmostat in a manner similar to that necessary to stop hemorrhage from a small vessel. In every instance in which a nerve was pinched the corresponding vocal cord was paralyzed. In all animals that lived long enough, the function of the cord was later fully restored. The time necessary for the restoration of the function depended on the anatomical point at which the nerve was pinched. When the trauma was applied to the nerve at its entrance into the larynx the function of the cord was found to be restored as early as thirty days after operation; when the nerve was pinched below the lower pole of the thyroid, sixty days elapsed before the cord functionated normally.

Three kinds of suture material were used to study the effect of ligation, linen, chromic catgut Nos. 1 and 2, and plain catgut No. 1. The nerves were ligated with about the same tension used in ligating small vessels. Every cord, where the nerve was ligated, was paralyzed, and in no instance was recovery noted, although in the majority of experiments the observations were carried on long enough for regeneration to have occurred. It seems that all suture material produces enough permanent obstruction to prevent regeneration in a nerve as small as the laryngeal. At autopsy this obstruction, due to the suture material or the reaction to it, could be definitely located grossly.

Several of the nerves were sectioned and allowed to drop back into their original position. The cords paralyzed by the procedure never recovered. Some of these nerves were examined at autopsy and the ends were found to be as far apart as .5 cm.

Three methods were employed to stretch the nerves. In some instances a hæmostat was placed under both nerves and traction was applied for a definite length of time, which varied from ten to thirty minutes. In other experiments small retractors were placed on each side below the lower pole of the thyroid and traction outward was made for a definite length of time. In the latter case the nerve itself was not disturbed. Finally the nerve was dissected free for a considerable length and after splitting one of the muscles of the neck the nerve was sutured around it in such a manner as to place

it on tension. In all instances the stretching was more severe than would occur during operation and by the first two methods only produced paralysis in one case. It is possible that this was due to trauma at the time of exposure and not to the stretching. When the nerves were stretched over muscles, paralysis occurred more frequently, but this also was due probably to the operative trauma and not to the stretching.

In several animals the nerves were dissected free for several centimetres (explored). In some cases paralysis followed, probably due to the trauma incident to freeing the nerves.

In four experiments the superior laryngeal nerves were sectioned. Subsequent examination of the vocal cords did not reveal any impairment of function.

The table gives the data in an abbreviated form. Many of the experiments were ended prematurely because of an epidemic of distemper.

CONCLUSIONS

1. Section of the recurrent laryngeal nerve produces complete paralysis of the vocal cord of the corresponding side which in all probability will be permanent.

2. Ligation of the recurrent laryngeal nerve with linen, chromic catgut or plain catgut produces complete and probably permanent paralysis of the vocal cord of the corresponding side.

3. Stretching the recurrent laryngeal nerves acutely in a manner similar but of longer duration and intensity than occurs in operation does not impair the function of the vocal cord.

4. Stretching the recurrent laryngeal nerves for a long period, as over muscles, impairs the function of the vocal cords, but the impairment is probably due to the operative trauma and not to the stretching.

5. Pinching the recurrent laryngeal nerves with a hæmostat in a manner similar to that which may occur in an operation, produces temporary paralysis of the vocal cords. Restoration of function always occurs, the length of time necessary for restoration depending on the anatomical point at which the nerve was crushed. The time found necessary for complete regeneration of the nerve when injured in the areas usually traumatized by operation varies between thirty and sixty days.

6. Exploration of the recurrent laryngeal nerves produces an effect on the vocal cords depending on the amount of trauma to which the nerves are subjected. Careful dissection will probably not produce any effect; the paralyses noted were probably due to pinching and other traumatic procedures.

SUMMARY

Pinching; number of nerves pinched, 24. All cords were paralyzed. The function of all the cords in which the nerves were pinched at the lower pole of the thyroid was restored within sixty days. When the nerves were pinched close to the larynx the function of the cords was found to be restored within thirty days.

Ligation with chromic catgut; number of nerves ligated, 9. All cords were paralyzed. The function was never restored. Longest time observed after operation was 371 days.

Ligation with plain catgut; number of nerves ligated, 6. All cords were paralyzed. The function was never restored. Longest time observed after operation was 320 days.

Ligation with linen; number of nerves ligated, 4. All cords were paralyzed. The function was never restored. Longest time observed after operation was 372 days.

Section; number of nerves sectioned, 8. All cords were paralyzed. The function was never restored. Longest time observed after operation was 372 days.

Resection; number of nerves resected, 1. The cord was paralyzed. The function was not restored after 160 days.

Stretched (acute); number of nerves stretched, 9. In one case the cord was paralyzed. No paralysis occurred in eight cases.

Stretched over muscles; number of nerves used, 4. Three cords were paralyzed. The function of two was restored within forty-eight days; the third was still paralyzed on twenty-second day.

Explored; number of nerves explored, 8. Three were not paralyzed; three were paralyzed and remained so at end of fifteen, eighteen and nineteen days, respectively. The function of one was restored in fourteen days; the function of another was partially restored after twenty-three days.

TABLE SHOWING THE RESULTS OF EXPERIMENTS ON THE EFFECT OF TRAUMATIC PROCEDURES TO THE RECURRENT LARYNGEAL NERVES

Experiment	Operation (pinched)	Results
494–16	Pinched right nerve	Complete paralysis. No restoration of function at the end of 17 days.
500–16	Pinched both nerves	Complete paralysis. Function of left corp restored within 40 days; function of right cord normal within 63 days.
511–16	Pinched right nerve	Complete paralysis. No restoration of function on fourth day.
512–16	Pinched right nerve	Complete paralysis. No restoration of function within 15 days.
598–16	Pinched both nerves	Complete paralysis. No restoration of function within 10 days.
599–16	Pinched both nerves	Complete paralysis. Function fully restored 50 days.
600–16	Pinched both nerves	Complete paralysis. Function fully restored 50 days after operation.
611–16	Pinched left nerve	Complete paralysis. Function fully restored 48 days after operation.
651–16	Pinched left nerve at level of lower pole of thyroid. Pinched right nerve 5 cm. below point at which left was pinched	Complete paralysis. Function of left cord restored 49 days after operation; right was still slightly paralyzed. It completely regenerated later.
654–16	Pinched right nerve	Complete paralysis. No restoration of function at end of twenty-second day.
663–16	Pinched right nerve	Complete paralysis. No restoration of function within 18 days.
664–16	Pinched both nerves near lower pole of thyroid	Complete paralysis. Function restored within 45 days.
738–16	Pinched right nerve below level of lower pole of thyroid; pinched left nerve just below point of entrance into larynx	Complete paralysis. Function of right cord not restored within 26 days; function of left about half restored.
739–16	Pinched both nerves at entrance to larynx	Complete paralysis. Twenty-sixth day right cord paralyzed 2; left cord paralyzed 1; thirtieth day right cord paralyzed 1; left cord normal; thirty-third day right cord normal.
740–16	Pinched right nerve	Complete paralysis. No restoration of function within 24 days.
741–16	Pinched both nerves	Complete paralysis. No restoration of function within 25 days.

TABLES SHOWING THE RESULTS OF EXPERIMENTS ON THE EFFECT OF TRAUMATIC PROCEDURES TO THE RECURRENT LARYNGEAL NERVES—*Continued.*

Experiment	Operation (ligated with chromic catgut)	Results
503–16	Ligated right nerve	Complete paralysis. No restoration of function within 75 days.
504–16	Ligated both nerves	Complete paralysis. No restoration of function within 46 days.
505–16	Ligated right nerve	Complete paralysis. No restoration of function within 318 days.
506–16	Ligated right nerve	Complete paralysis. No restoration of function within 371 days.
611–16	Ligated right nerve	Complete paralysis. No restoration of function within 22 days.
613–16	Ligated right nerve	Complete paralysis. No restoration of function within 110 days.
665–16	Ligated right nerve	Complete paralysis. No restoration of function within 18 days.

Experiment	Operation (ligated with plain catgut)	Results
601–16	Ligated both nerves	Complete paralysis. Left cord removed ninth day for marked dyspnœa. No regeneration of right nerve within 320 days.
742–16	Ligated both nerves	Complete paralysis. No restoration of function within 22 days.
12–17	Ligated both nerves	Complete paralysis. No restoration of function within 228 days.

Experiment	Operation (ligated with linen)	Results
499–16	Ligated both nerves	Complete paralysis. No restoration of function within 16 days.
502–16	Ligated right nerve	Complete paralysis. No restoration of function within 372 days.
503–16	Ligated left nerve	Complete paralysis. No restoration of function within 75 days.
665–16	Ligated left nerve	Complete paralysis. No restoration of function within 18 days.

Experiment	Operation (sectioned)	Results
493–16	Sectioned right nerve	Complete paralysis. No restoration of function within 237 days.
509–16	Sectioned right nerve	Complete paralysis. No restoration of function within 262 days.
510–16	Sectioned left nerve	Complete paralysis. No restoration of function within 15 days.
511–16	Sectioned left nerve	Complete paralysis. No restoration of function within 11 days.
512–16	Sectioned left nerve	Complete paralysis. No restoration of function within 22 days.
655–16	Sectioned left nerve	Complete paralysis. No restoration of function within 90 days.
10–17	Sectioned right nerve	Complete paralysis. No restoration of function within 7 days.

TABLES SHOWING THE RESULTS OF EXPERIMENTS ON THE EFFECT OF TRAUMATIC PROCEDURES TO THE RECURRENT LARYNGEAL NERVES—*Continued.*

Experiment	Operation (resected)	Results
493–16	Resected 5 cm. of left nerve	Complete paralysis. No restoration of function within 237 days.

Experiment	Operation (stretched for period of operation)	Results
508–16	Stretched both nerves for short interval, probably two minutes	Cords normal.
509–16	Stretched left nerve	Cord normal.
656–16	Stretched both nerves for ten minutes	Cords normal.
666–16	Stretched both nerves for twenty minutes	Left cord paralyzed 3. Right cord normal. Both cords normal within 18 days.
13–17	Stretched both nerves for twenty minutes	Cords normal.

Experiment	Operation (stretched by suturing around muscles)	Results
653–16	Sutured both nerves around muscles	Complete paralysis. Function restored within 218 days.
651–16	Sutured left nerve around muscles	Complete paralysis. No restoration of function within 22 days.
655–16	Sutured right nerve around muscles	Cord normal.

Experiment	Operation (explored)	Results
502–16	Explored left nerve	Cord normal.
510–16	Explored right nerve	Complete paralysis. Did not recover within 15 days.
665–16	Explored left nerve	Complete paralysis. Did not recover within 18 days.
9–17	Explored both nerves	Complete paralysis. After 6 days left cord paralyzed 2; right cord complete; after 10 days left 1, right 3; after 14 days left O. K., right 3; after 23 days right 2. Both cords normal on eighty-ninth day.
10–17	Explored left nerve	Cord normal.
11–17	Explored both nerves	Left cord normal; right paralyzed; bloody effusion from wound; much bleeding on right side at operation. Right cord still paralyzed after 20 days.

PNEUMOCOCCUS PERITONITIS*

By Parker Syms, M.D.

of New York

surgeon to the Lebanon and to the City Hospital

Because I believe diagnosis in connection with this disease to be of great importance as bearing on its proper treatment, and because there is such a paucity of American literature concerning it, I have been prompted to bring this subject before the New York Surgical Society.

Idiopathic pneumococcus peritonitis does exist, and in its diffuse form or stage operation is extremely dangerous, usually resulting in death. I believe operation should be avoided in this phase of the disease. Were this not a fact we could hold the dictum that for acute peritonitis in child or adult immediate operation is the proper form of treatment. But this exception exists and it makes it doubly important that we should have the salient features of this disease ever in mind when we encounter a case of acute peritonitis.

A search through the literature reveals many excellent articles from England, France, Italy, and Germany, but very little is to be found in American journals. During the last seven years no article has appeared in *Surgery, Gynecology and Obstetrics,* and during the last ten years but one article has appeared in the Annals of Surgery and but one article in *The American Journal of Medical Sciences.* I believe a more general recognition of this disease is needed in order that we may clear up certain points which still require elucidation. The greatest practical good can come from a systematic study of all of our acute peritonitis cases with the picture of this disease ever before us.

We have gradually come to realize that pneumococcus peritonitis is a clinical entity. Prior to 1889, when appendicitis was first operated upon, we knew comparatively little about peritonitis. What we thought we knew was based upon clinical experience and upon observation made at necropsy. During that period of comparative ignorance much was said about idiopathic peritonitis. After 1890 laparotomy for acute appendicitis became one of our most common procedures. Then it was found that peritonitis was almost invariably the result of infection from a hollow viscus—appendix, intestine, gall-bladder, etc., and we came to feel that there was no such thing as idiopathic peritonitis, except the tubercular form; but the experience of opening the abdomen and finding a diffuse or encysted peritonitis, with the appendix, gall-bladder, and uterine appendages normal, and with no evidence to be found of an original focus of infection, demonstrated the fact that peritonitis may begin as a primary or idiopathic lesion. A further study has led to the discovery that acute idiopathic peritonitis may be caused by the gonococcus, the streptococcus, and the pneumococcus, and

* Read before the New York Surgical Society, December 12, 1917.

that chronic idiopathic peritonitis may be caused by the tubercle bacillus. N.B. The colon bacillus, though always present in the intestine, does not cause peritonitis, except by perforation or extension.

For a historic sketch or review of the study of this disease I take the liberty of transcribing that which is found in the excellent article by Annand and Bowen.[1]

"In 1885 de Bozzola[2] described a case of infection of several serous cavities with numerous capsulated cocci in the exudate following on a nephritis. The case, however, was not fully worked out. In the following year Cornil[3] performed a necropsy on a case of pneumococcus peritonitis following pneumonia and associated with double empyema and pyopericarditis. During the next year or two isolated cases were here and there reported and in 1890 Nelaton[4] undertook the first operation for the relief of the condition, in a woman aged thirty-two, but without success. Galliard[5] and Sevestre[6] also operated during the same year on cases of pneumococcus peritonitis; Sevestre's case being a child with apparently primary involvement of the peritoneum. This case recovered and remained well. On the continent numerous examples of the disease now began to be recorded, for the most part from France. In 1903 Von Brunn[7] was able, in an excellent paper on the subject, to collect 57 cases of the disease in children and a further 15 adult cases. In the same year Jensen,[8] of Copenhagen, published a lengthy article on the disease, and in this he discussed the affection very fully. These two papers are up to now the most important contributions to the subject. Since the date of Von Brunn's paper, Mathews[9] and Bryant[10] have brought forward fresh cases and have written on pneumococcus peritonitis; other papers have been contributed by Quervain[11] and Ghon,[12] while cases have been reported by Panzacchi,[13] Brun,[14] Powell,[15] Taylor,[16] Waldo,[17] Webber,[18] Fisher,[19] Dudgeon and Sargent,[20] Davies and Langdon Brown,[21] and Duckworth and Marsh.[22] As a result of a search of the literature we have been able to find record of 91 cases of pneumococcus peritonitis in children below the age of fifteen years, including the cases reported above."

In 1904 Frank Mathews[9] published a paper in the ANNALS OF SURGERY. He reported 5 fatal cases. He reviewed and analyzed the work of Jensen[8] and that of Max Von Brunn.[7]

In 1908 H. D. Rollerston[23] published an article on the subject in the *Clinical Journal of London,* and in 1911 George Woolsey[24] published a paper in *The American Journal of Medical Sciences.* In 1912 there appeared a paper by Hector Cameron[25] in *The British Journal of Children's Diseases.* One of the most recent articles on the subject is by L. M. Kahn, published in 1914.[26]

Among the most notable contributions to this subject may be cited those of Jensen,[8] Von Brunn,[7] Annand and Bowen,[1] Brun,[14] of Paris, and Michaut.[27] Michaut's thesis, so far as I know, is the most comprehensive brochure on the subject. In it can be found the sum of our present-day knowledge. I believe that very little has been added to our fund of information on this subject since Michaut's article was published in 1901.

Perhaps the best way to systematize our study of this subject will be to set down succinctly the facts which we have learned and which we recognize on the one hand, and then to set forth certain important features of the disease which have not yet been made clear, and whose elucidation may give

us a much more perfect conception of the subject, and also may enable us to treat this disease on a more definite and scientific basis.

From the recorded study of this subject, especially from the many case reports, we have learned certain facts as follows:

Idiopathic peritonitis caused by the pneumococcus is a pathological entity.

It is a rare disease. In 104 pneumococcus infections in adults that were studied by Netter,[28] he found no case of peritonitis. In 47 such infections in children, he found 1 case. In 140 cases of peritonitis which were bacteriologically examined by Netter,[28] he found pneumococcus twice.

It is a disease particularly affecting children. Up to the fifteenth year of age it is three times as prevalent as after that period.

It is much more frequent among girls than among boys in the proportion of three to one.

It may occur (1) as the only local manifestation; (2) as a sequel to some previous site of pneumococcus infection, *i.e.*, lung, pleura, pericardium, ear, etc., or (3) as a part of a general septicæmia in which other organs are simultaneously involved.

It is found in two varieties: (1) As a diffuse general peritonitis and (2) as an encysted or localized process. Some claim that these two conditions represent stages of the disease, that there is always a diffuse peritonitis at first which later becomes localized by intestinal adhesions. Others (Michaut[27]) claim that there are two distinct varieties of the disease.

The disease has been described as occurring in three stages, some say four.

The first stage is that of toxæmia, the child being overwhelmed by the poison. There is great depression and the patient is much more ill than the abdominal symptoms would indicate.

The second stage is characterized by abdominal symptoms; the signs of an advancing peritonitis.

The third stage is characterized by a continuance of the signs of peritonitis with effusion. During this period there is often an abatement of the active signs of toxæmia. The temperature may fall and the patient may seem decidedly less ill. If the pus has become encysted or localized there will be the signs of intra-abdominal abscess or abscesses. The abdomen becomes distended; this particularly relates to the lower part of the abdomen, for the disease is usually subumbilical. When loculation has taken place there is usually an irregular swelling of the abdomen, one side being affected more than the other. One characteristic of the disease in its late stages is the protrusion of the umbilicus and its final perforation. There have been many reports of discharge of pus through the umbilicus and this seems to be a condition almost peculiar to this disease. The discharge will be of the characteristic greenish-yellow, serofibrinous, odorless pus. N.B. If perforation at the umbilicus takes place in tubercular peritonitis there is very apt to be a fecal fistula.

The disease presents a clinical picture that is characteristic and which should lead to diagnosis in most primary cases. Its characteristic signs are sudden onset, extreme toxæmia, vomiting and diarrhœa, very high temperature, and very high leucocytosis with a high polymorphonuclear count. There is a notable absence of local pain, local tenderness, and local rigidity as compared with appendicitis or perforation peritonitis. Some have described the abdomen as having a "doughy" feel. Added to all this is the pneumonia aspect—cyanosis, slight dyspnœa, great depression, etc.

If the abdomen is opened there will be found a diffuse or a localized peritonitis or one that is becoming localized. As a rule no one organ will indicate a starting point (as an inflamed appendix, gall-bladder, etc.). The appearance of the exudate is characteristic and almost pathognomonic. It is a seropurulent fluid, perfectly odorless, of a yellowish-green color and containing great masses of fibrin. This fibrin is found floating in the exudate and also attached to the peritoneal surfaces.

Opinions differ as to whether there are two distinct varieties of pneumococcus peritonitis. Some claim that the diffuse peritonitis is a distinct type having a tendency to remain diffuse and to produce extreme toxæmia, and that the encysted is another type having a tendency to become localized early and to produce a lesser degree of toxæmia. (Of course, even the encysted cases are not encysted from the very beginning, it is the tendency to early localization that represents the difference.) Others claim that diffuse peritonitis without adhesions represents the first stage, and that adhesions with the formation of localized accumulations represent a later stage.

F. Brun,[14] who was an early writer on the subject, at first reported some cases of encysted pneumococcus peritonitis in which he found a very favorable outcome. In a later report he again cited some cases of the encysted form and published his conclusion that this was a rare form of peritonitis in which the prognosis was very good. He stated that it was one of the least fatal forms of peritonitis found among children. But later he encountered a group of cases of the diffuse variety which prompted him to make a subsequent report, for these diffuse cases proved extremely fatal. He concluded therefore that this second was a distinct variety having a much higher mortality than the encysted type.

Later his associate, Charles Michaut,[27] reported these cases of Brun's with some cases of his own and analyzed a collection of cases reported by others. Michaut [27] very clearly states the view that the two forms are two distinct varieties, and that each is caused by a strain of pneumococcus different from the other; the first being caused by a pneumococcus of comparatively little virulence, the second being caused by a pneumococcus of extreme virulence. This is one of the points yet to be cleared up and it can only be done by making a very careful study of our cases and a very careful and intelligent study of the bacteriology of each case until we have a sufficient number on which to base conclusions.

Von Brunn [7] speaks of the disease as having a favorable prognosis in

which spontaneous recovery may take place and in which recovery is the rule in cases operated. It is evident that his observations and impressions must have been gained from an experience with cases of the encysted form of peritonitis. Mathews [9] clearly pointed this out.

Hector Cameron [25] states his position very clearly when discussing the question of treatment. He regards the diffuse form of the peritonitis as belonging to the early stage and not as representing a distinct type of the disease.

Whether diffuse pneumococcus peritonitis is an early stage or a special form of the disease, the fact remains that it represents the period or condition of the utmost gravity. Annand and Bowen,[1] analyzing 91 cases that had been bacteriologically studied and satisfactorily reported, found in the diffuse form a mortality of 86 per cent. In the same series of cases in the encysted form there was a mortality of but 14 per cent.

In the same article Annand and Bowen [1] describe 16 cases which had occurred in the East London Hospital for Children. All 16 of these cases were of the diffuse variety. Death resulted in all 16, showing a mortality of 100 per cent.

Brun,[14] as quoted above, found the diffuse to have a much higher mortality than the encysted form.

Michaut's [27] investigation fully supports this fact. He believes the two conditions represent two varieties of the disease, each variety caused by a pneumococcus having a special degree of virulence. If the diffuse variety is caused by a bacterium of great virulence, the toxæmia will be great and the gravity of the disease will be in proportion to the virulence of the pneumococcus. The mortality will be high in proportion to the strain of pneumococcus involved. Does not this correspond with our modern investigation of the pneumococcus?

Cameron [25] regards the diffuse form as representing the period of maximum danger. He strongly advises against operation during this state. He gives several reasons to show that operation, in the diffuse form, is contraindicated. The most cogent of all is to be found in the fact that operation shows so high a mortality—from 86 to 100 per cent.

L. M. Kahn [26] expressed essentially the same view as Cameron.[25] He regards the diffuse form as a stage, not a type of the disease. He recognizes its extreme gravity. He advises against operation in the diffuse "stage," and he very properly lays stress on the necessity for diagnosis.

In fact, all writers who have gone into this phase of the subject are essentially agreed.

Diagnosis.—All must recognize the importance of correct diagnosis of this condition. When we encounter a case of acute peritonitis, one of the first essentials is that we decide whether that case is or is not one of pneumococcus peritonitis, and if it is pneumococcus peritonitis whether it is diffuse or encysted. Because diffuse pneumococcus peritonitis should *not* be operated upon; encysted pneumococcus peritonitis *should* be operated

upon. All other forms of acute peritonitis, diffuse or encysted, should be operated upon, and the earlier the better.

The picture of primary pneumococcus peritonitis is so characteristic that diagnosis should be possible in typical cases. The salient points are: the sudden onset, the evidence of extreme toxæmia, great depression, etc. There is often a chill, there is always extremely high temperature, the blood count is very high. Diarrhœa is a conspicuous symptom; peritonitis with diarrhœa should always make one suspicious of pneumococcus. As compared with perforation-peritonitis there is lack of localizing symptoms; there is a lack of local pain, of local tenderness, of local rigidity. The abdomen is described as presenting a "doughy" feel. (Salzer.[29]) There may be the "pneumonia aspect"—cyanosis, dyspnœa, great depression, etc. The fact that the patient is far more ill than the abdominal condition would account for, is significant. As bacteræmia is generally, if not always, present, examination of the blood should be of great aid to diagnosis. In cases where a previous site of infection exists and where the peritonitis comes on as a secondary or late manifestation, the diagnosis will naturally be greatly obscured by the previous condition. Undoubtedly failure to diagnosticate peritonitis in such cases has been of frequent occurrence. When the peritonitis is established and when the effusion is formed there will be the signs of either free fluid in the abdomen or of loculated accumulations. In other words, there will be distention of the abdomen, either uniform or one-sided. This distention nearly always begins in the lower part of the abdomen; pneumococcus peritonitis usually begins as a subumbilical one. Protrusion or perforation at the umbilicus is a late sign and is very characteristic of this disease.

When the abdomen is opened there will be found the evidences of peritonitis described in a previous paragraph. As a rule, no local point of origin, as inflamed appendix, etc., will be found. Most diagnostic of all, however, will be the appearance and character of the exudate—an odorless, seropurulent fluid of a yellowish-green color, containing great masses of fibrin.

Clinically it is very difficult to distinguish between pneumococcus peritonitis and streptococcus. It is always very difficult to make the distinction by bacteriological examination, and undoubtedly many mistakes have occurred. This was well expressed for me by Dr. James G. Dwyer,[30] of Columbia University, as follows:

> "The differentiation between pneumococcus and streptococcus of atypical morphology is a very difficult thing, unless we carry out the full identification of each by immune serum tests, by the use of inulin, bile, etc. If these tests are done, the differentiation is final and complete. If this is not done, there is always a legitimate question as to the differential diagnosis."

Three out of five of our Lebanon Hospital cases which were operated upon gave a clinical picture of pneumococcus peritonitis and that was the surgical diagnosis insisted upon by the operators, and yet the pathologists

pronounced the bacterium in each of these three cases to be streptococcus and not pneumococcus.

A case reported by Dr. Nathan Green [51] is very interesting in this connection. A child was operated upon for peritonitis and the bacteriological examination showed the presence of streptococcus. During convalescence the child developed a metastatic abscess of the thigh. Examination of this latter pus showed pneumococcus. Query: Do these cases illustrate the difficulties of bacteriological determination?

> "A legitimate question as to differential diagnosis?" . . . Or do they indicate a possibility as to "The transmutations within the streptococcus-pneumococcus group."—E. C. Rosenow.[52]

Treatment.—I feel that it is very important to touch upon this phase of the subject at the present time. Nearly every writer who has contributed to this subject has stated unequivocally that laparotomy is the proper procedure in all cases. A careful review of case reports, however, will show how little warrant there is for this assertion.

For instance, Annand and Bowen [1] claimed that early operation was the proper form of treatment, and yet their own analysis of 91 case reports showed a mortality of 86 per cent. in the cases of diffuse peritonitis. Some case reports have shown a mortality of 100 per cent. in operations performed in the diffuse cases. On the other hand, operation is undoubtedly the correct form of treatment in the encysted cases. Without going into this question more fully again, I think we can agree with those (Cameron,[25] Kahn,[26] and others) who feel that operation is not the proper form of treatment when the peritonitis is generalized and when the toxæmia is severe. Under these circumstances the treatment should consist in open-air, general support, the Fowler position if the pulse will stand it, proctoclysis, in other words, the Murphy-Ochsner treatment for peritonitis.

When the peritonitis is of the encysted form, or has become encysted, and when the extreme toxæmia and depression are lacking, or have materially subsided, operation is undoubtedly the proper form of treatment. The localized collections of pus should be evacuated and the case should be treated according to the same surgical principles as would apply, in similar cases, to other varieties of peritonitis.

The serum treatment should have the same place in pneumococcus peritonitis as it has in pneumococcus infections elsewhere. I believe at present we recognize serum treatment to be of value in cases which are caused by group I pneumococcus. This being so, as a matter of science one should determine the type of pneumococcus, and use a number 1 serum when it is known that the bacterium belongs to group I. As a matter of practice it may be good sense to administer the serum without waiting for the exact determination as to the group of pneumococcus. Should it belong to group I we may expect great benefit, and should it not, we would simply be running the risk of a certain amount of serum disease.

At Lebanon Hospital were found records of 8 cases which were fur-

nished to me as cases of idiopathic pneumococcus peritonitis. As these reports were somewhat unsatisfactory, I do not feel like putting them on record in detail, but I think it may be useful to say a few words concerning them.

As to sex—there were 6 females and 2 males. As to age—there were 3 patients over fifteen years of age, and 5 patients under fifteen years of age. All of the 8 cases were of the diffuse variety; 8 patients were operated upon; 5 died, 3 recovered.

Three of the 8 cases were not examined bacteriologically. Of the 5 cases studied bacteriologically, streptococcus was found in 3. Pneumococcus was found in 2 cases. The 3 cases in which streptococcus was found presented the clinical appearance and characteristics of pneumococcus peritonitis, and such was the clinical and surgical diagnosis. In fact, the surgeons insisted that these were pneumococcus cases but the pathologist adhered to his finding of streptococcus, not pneumococcus. In reading the detailed reports of these 3 cases I would feel that there may be some doubt as to the type of bacteria. Unless full tests are made differentiation between the pneumococcus and streptococcus is very difficult.

In conclusion let us sum up:

Idiopathic peritonitis does occur.

Pneumococcus peritonitis is a rare disease. Netter found it twice in 140 cases of peritonitis bacteriologically examined. In 104 pneumococcus infections in adults he found no case of peritonitis; in 47 such cases in children he found one case.

Pneumococcus peritonitis particularly affects girls. Under fifteen years of age the proportion is three girls to one boy.

Pneumococcus peritonitis may occur (1st) as a single lesion, *i.e.*, alone; (2nd) as a sequel to some other site of infection, as the lung, pleura, etc.; (3rd) it may be followed by invasion of other localities, lung, pleura, etc.; (4th) it may be a local manifestation of a general septicæmia. Probably it is always that.

Pneumococcus peritonitis is found in two forms: (1st) the diffuse; (2nd) the encysted. These forms may represent different types or varieties of the disease or they may represent different stages of the disease. This is yet to be demonstrated.

When the peritonitis is encysted the prognosis is good, spontaneous recovery may take place in one of several ways. Operation results in a high percentage of recoveries (86 per cent.).

When the peritonitis is diffuse the prognosis is bad—death is the rule. Operation results in very high mortality (86 per cent.; in some series 100 per cent.).

We recognize a symptom syndrome which should make diagnosis reasonably certain in typical cases.

Operation should not be performed in the diffuse form.

Operation should always be performed in the encysted form.

The above represents the sum total of our present-day knowledge of this subject as set forth in the literature to date.

While I have nothing new to add to this subject, I feel that I may be performing a service by propounding certain questions which have not yet been answered. The satisfactory solution to some of these questions would go a long way toward improving our treatment of this disease.

CERTAIN POINTS OF INTEREST AND IMPORTANCE WHICH ARE YET TO BE CLEARED

1. Why is the disease most common among children?
2. Why is the disease more common among girls than among boys?
3. How does the disease invade the peritoneum?
4. Is there a local port of entry?
5. Is there always septicæmia?
6. Will the blood always show pneumococcus? If not, in what per cent.?
7. Is the secondary form caused by blood infection?
8. Why is diarrhœa so frequently a symptom?
9. Is there commonly an enteritis?
10. Do the diffuse and encysted forms represent types of the disease, or do they represent stages?
11. If they are two different types of the disease, are they caused by different types or strains of pneumococcus?
12. Have pneumococci been classified in this and in other lesions, as they have been classified in pneumonias?
13. What can we hope from serum treatment in this disease?
14. Are the chlorides diminished in pneumococcus peritonitis as they are in pneumonia?
15. Will the administration of chlorides show the same benefit they have shown in the treatment of pneumonia?

Before closing, I will touch briefly upon some of these questions: The first four are really of academic interest, and will undoubtedly be answered more or less completely as time goes on.

5, 6, and 7 may be covered by one answer. There is undoubtedly always a bacteræmia; the peritonitis is really a local manifestation of a systemic infection. When peritonitis is secondary to some other lesion, as pneumonia, for instance, the disease doubtless reaches the peritoneum through the blood stream. Undoubtedly the blood should always show the presence of pneumococci. I cannot do better than to again quote the words of my friend, Doctor James G. Dwyer, to whom I put this question:

"The disease probably gains access to the peritoneum through the blood. It is probably always a bacteræmia, the organisms circulating through the blood and localizing in the peritoneum. Blood cultures if taken often enough, at the proper time and sufficient blood drawn, would be a valuable method of diagnosis on this point. A negative blood finding would have no meaning, as the mechanical and bacteriological reasons of why we get negative blood cultures when we should get positive hold good here. Blood cultures should show a bacteræmia."

10, 11, and 12 may similarly be expressed in one answer. Thus far the pneumococcus in its relation to peritonitis has not been systematically studied as it has in its relation to pneumonia, though some investigation along this line was made by Michaut many years ago.

Whether the diffuse peritonitis cases with extreme toxæmia represent a distinct type and are caused by a strain of pneumococcus of extreme virulence (group III) remains to be proven. It is a matter of the greatest importance and should receive the fullest possible investigation. For this purpose, bacteriologically, our peritonitis cases should be subjected to the most intensive study.

Serum therapy should have the same place here as it has in the treatment of pneumonia.

The questions as to the chlorides yet remain to be investigated and answered.

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OBSTRUCTIVE (MALIGNANT) JAUNDICE

OPERATIVE RELIEF BY CHOLECYSTOGASTROSTOMY, ETC.

By John F. Erdmann, M.D.
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"All cases of obstructive jaundice are entitled to operative consideration. There is a certain definite percentage of cases that are cured because there has been a mistake in the diagnosis. These operations are advised solely as palliative procedures and as such they perforce must be clearly understood."

These above conclusions are found as number 1 and 5 in a recent article: "Relief of Chronic Obstructive Jaundice by Palliative Operation," by John F. Erdmann and Charles Gordon Heyd, *American Journal of the Medical Sciences*, August, 1916.

My clinical experience with this type of patient during the two years passed since the above mentioned article was written more than convinces me of operative procedure. Reviewing the literature of obstructive jaundice and recalling the material presenting itself in our large hospitals, renewed suggestions for operative relief of chronic cholæmia within two years I hope may not be amiss.

I am considering, therefore, those cases of biliary and pancreatic obstruction, with or without duodenal involvements, incident to malignant disease or irremovable tumors about the terminal portion of the common and pancreatic ducts.

As persistent and increasing jaundice is in the large majority of cases due to malignant disease, what can be done in the way of palliation for these patients should be considered. Little comment is necessary to describe the clinical picture of chronic obstructive jaundice. The rapid loss of weight, emaciation and asthenia, pruritus and disturbing mental conditions incident to cholæmia often render attempts at operative relief imperative. The mechanical factors evidenced in organic occlusion extrinsic to the common duct but still within the head of the pancreas, or those intrinsically of the duodenum, *i.e.*, those growths of the ampulla of Vater, etc., will by their anatomic position enable one to establish such operative procedure best fitted for relief.

Without question it follows that relief to biliary stases must be provided by operative drainage between some portion of the biliary apparatus and the gastro-intestinal tract, or by an opening into the biliary tract communicating with the outside world; this latter, while having been an operation of choice formerly, must be excluded from our present-day operative procedure for more reasons than that of soiling the surroundings. Chief among these is the physiological loss of biliary salts, etc.

Indications for operation in malignant obstruction to the flow of bile are:

1. Possible mistaken diagnosis, as not infrequently an operator for sup-

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posed malignancy finds a benign condition which is rapidly corrected by instituting drainage, etc. These are the patients in whom we obtain so-called cure from malignancy. Moynihan aptly says: "No one living is infallible in the differential diagnosis of obstructive jaundice. The diagnosis is always so difficult and the chance of a life saved so important that however positive the evidence of malignancy may be, I now advise operation in all cases."

2. The relief of distress in pain (back pressure upon the biliary system): Some patients complain of this symptom only. All do not suffer from pruritus, or the mental states.

3. Pruritus of an intractable degree or nature: In many patients this symptom is so severe that the patient demands operative relief. I have had them threaten suicide if operation was refused.

4. Social or business: To prolong life in comparative comfort; to give the patient relief from his jaundice and pruritus so that he may live with his family or conduct his business until such time as death takes place from metastasis, exhaustion, etc. This has been demonstrated in several of my patients recently, two living two years in comfort and able to attend to their business to within a short period of their deaths.

5. Surgical euthanasia: The primary operative mortality in these conditions will be high, but considering the absolutely hopeless outlook, together with the urgent demand for relief, one is warranted in selecting an operative procedure.

A neoplasm at the ampulla of Vater, by kinking the duct or by pressure œdema of the mucous membrane of the duct, or by extension into the duodenum, will bring about not only biliary, but also pancreatic obstruction of variable degree. The duct of Wirsung carries the entire pancreatic secretion in about 83 per cent., while the duct of Santorini is the main duct in 12 per cent. In 54 per cent. the duct of Santorini acts as a substitute for the duct of Wirsung. In certain cases the duct of Santorini remains uninvaded for a long period of time. Again, the duct of Santorini not infrequently connects with the duct of Wirsung; in these patients complete biliary stasis exists, while pancreatic drainage into the duodenum is not evidenced. While this is likely to be a rarity, aside from theoretical interest, it presents no technical interest over the usual case.

Cholecystenterostomy will deliver the biliary secretion into the intestinal tract. The stools will then contain bile, and the bile disappears from the skin and urine; but this operation could, however, only rarely affect the pancreatic, and in the few cases that it did influence, pancreatic drainage would depend upon retrograde flow into the common duct, then into the cystic and then through the gall-bladder into the intestines.

Most of the patients suffer from a lack of pancreatic secretion in the intestines with a lack of pancreatic digestion, evidenced by bulky, frequent stools, showing an increase in the amount of fats and changed relationship between saponified and unsaponified fats, and the absence of adequate protein digestion. Therefore, these cases may proceed to a rapid death as a result of

this pancreatic deficiency, although the elimination of jaundice and biliary stasis has been accomplished by cholecystenterostomy.

Chronic obstruction of the duodenum below the ampulla of Vater will give in addition to biliary stasis the signs of pyloric obstruction. Two of my cases, one a young man of seventeen years, gave the dual picture clinically of pyloric obstruction and biliary stasis. It is usual to find the distended gall-bladder of Courvoisier accompanying obstructive conditions in the distal portion of the common duct; occasionally instead of the bladder being filled with bile, as is usual, the contents have been observed by myself and assistants to be cystic in character. This is explained by Kausch, quoted by Outerbridge, as a pressure acholia. The common hepatic and cystic ducts are filled with the same type of clear mucoid fluid. In Kausch's patient, after drainage had been established a few hours, the discharge began to assume a biliary stain. In six hours, almost pure bile flowed and continued so until death. Autopsy showed a carcinoma of the papilla of Vater. He (Kausch) thought this hydrops in these patients due to excessive mucus secretion in the gall-bladder and ducts; the duodenal opening being closed or impervious, that the biliary secretion, then due to pressure in the biliary system, being so raised that the secreted bile is poured back into the blood- and lymph-vessels of the liver.

The most frequent cause of obstructive jaundice is carcinoma of the pancreas, ampulla or duodenum. Cancer of the duodenum represents about 0.4 per cent. of all carcinoma, and of these about 70 per cent. are of the ampulla of Vater. Pancreatic cancer is the most fatal of any form of carcinoma; death ensues from seven to eight months from the onset of noticeable symptoms and occurs before metastases obtain any great extension. Upcott, p. 717, says there is probably no position within the body outside the central nervous system where a growth, while yet so small, is heralded by more widespread symptoms than at the lower end of the common duct. Excision of growths at the ampulla is rare and the results not encouraging. Of 22 such cases reported up to about November, 1915, 8 primary and 5 subsequent deaths occurred. Of 5 surviving any length of time, 2 were well at seven months, 1 ten months, 1 two years, and 1 at three and three-quarters years.

Operative Consideration.—Recall that I have specifically stated that these operations in the main are palliative; therefore given an obstruction to the common duct, or its terminus, the ampulla of Vater, we have a variety of operations to choose from.

The simplest—cholecystostomy as stated above—is not to be considered, except as a primary step, as this operation, through loss of biliary salts and body fluids, including the pancreatic juices in some patients, is likely to be followed by a rapid demise. Whereas, in an anastomosis with some portion of the gastro-intestinal tract all the afore-mentioned secretions are retained. Anastomoses between the hepatic duct and some contiguous organ, while theoretically easy, are practically very difficult and accompanied by an increased mortality.

The choice of operations depends upon numbers of factors, as, (1) physiological efficiency; (2) ease of accomplishment; (3) immunity from ascending infection; (4) effects immediate and remote on the patient's metabolism. Cholecystoduodenostomy will more nearly simulate the normal or rational condition of biliary drainage. Owing to the fixity of the duodenum in many patients this operation is accompanied with a greater degree of difficulty in technic and also therefore by a greater mortality than a cholecystogastrostomy. The operation of cholecystogastrostomy was performed by Moynihan 21 times; 20 patients recovered from the operation and lived for several months or years, without suffering disability which could be attributed to the entrance of the bile into the stomach. My own experience in this operation bears out the above. I have not seen one patient in whom I have done the operation where any untoward symptoms presented. On the contrary, all felt relief from the previous symptoms in from one to three days. I have performed cholecystogastrostomy 18 or 20 times during the past four years—in two of these patients adding a posterior gastro-enterostomy, owing to a carcinoma of the papilla of Vater, producing duodenal obstruction.

Considering the merits of cholecystogastrostomy, cholecystenterostomy, cholecystoduodenostomy and cholecystocolostomy proves that the best results are obtained with cholecystogastrostomy. Physiologically no objection to the presence of bile in the stomach has been demonstrated. Technically this operation is more easily performed than any other of the recommended procedures, as the structures in this type of anastomosis are intimately associated and of easy access, little or no mobilization being required. Cholecystenterostomy carries with it the possibility of a later angulation, and an accompanying entero-enterostomy on the loop of the intestines—this added operation being a source of added risk and mortality.

Cholecystoduodenostomy frequently presents difficulties of depth in the anastomosis and occasionally extensive adhesions work to bring about difficulties of mobilization for suture. Cholecystocolostomy has been done by me twice. In both instances it was an operation of expediency, due to massive adhesions and inability to thoroughly expose either stomach or small intestines. This operation is contra-indicated because of (1) the possible reflux of the high bacterial charged content of the colon; (2) the possibility of reversed mucus currents, described by Bond; (3) the loss of digestive functions of the bile, especially the saponification of fats; (4) the fact that the bile is so soon lost in the stools may mean a rapid loss of the salts of the bile which would normally be reabsorbed in the intestine in the event of a higher anastomosis. Nevertheless, it is rather instructive that my first cholecystocolostomy, done in a patient over seventy, accomplished all the desired results, the patient living over seven months, being carried off by an acute cardiac lesion. During the past year I operated upon a patient who entered Gouverneur Hospital in shock with a scar over his duodenal zone, a board-like abdomen, inability to give any history. An emergency operation was done, thinking that he had a perforated duodenal ulcer. Upon exposing the contents in the upper right quadrant, exudate and adhesions in plenty were

found. No free fluid, etc., was found in the abdomen, but a greatly distended gall-bladder with its fundus attached to the transverse colon was exposed. Upon dissection it was easily demonstrated that a cholecystocolostomy had been performed. The bladder contents could not be emptied into the colon. Upon separating the bond of union and investigating, it was observed that the gall-bladder was filled with fluid fæces and a large piece of fruit skin, possibly from a prune, was occluding the artificial opening in the gall-bladder. The contents of the gall-bladder were cleaned out, the opening into the colon closed and the gall-bladder then anastomosed to the stomach. There were no after symptoms of any untoward nature, although the drainage from the liver ducts and the gall-bladder must have been highly toxic for several days. Subsequent questioning of our recovered patient elicited the facts that he had been operated upon in one of our large city institutions for an obstructive jaundice about eight months before.

My youngest patient was seventeen years of age, while my oldest was over seventy. Hepaticoduodenostomy was done but once. In this patient, owing to a malignancy at the cystic duct junction, no other operation was possible. The hepatic duct was dilated to fully the size of one inch in diameter, thereby facilitating the anastomosis.

ACUTE AND SUBACUTE PANCREATITIS*

REPORT OF SEVEN CASES

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Although acute pancreatitis with fat necrosis was first described by Balser in 1882, it was not until the appearance of Fitz's classical papers in 1889 that the interest of the medical world was aroused, and inflammatory diseases of the pancreas began to be studied clinically and in the laboratory. Inasmuch as such cases are rather rare, animal experimentation has proved of the greatest benefit in elucidating many problems connected with them. This is particularly true of the acute inflammations of the pancreas, for the chronic conditions do not lend themselves well to animal experimentation. Our knowledge of chronic pancreatitis is, therefore, largely the result of observations made at the bedside and in the course of operations upon the biliary apparatus.

Etiology of Acute Pancreatitis.—Acute hemorrhagic pancreatitis is said to occur more frequently in men than in women, the proportion being about two to one, but five of my cases were women and two were men. With few exceptions the disease occurs between the ages of twenty and fifty years; obesity and alcoholism are believed to favor its occurrence. About 1901 Opie, whose name is prominently associated with our knowledge of all conditions affecting the pancreas, performed an autopsy upon a case of acute pancreatitis, which had been operated by Halsted, and discovered in the ampulla of Vater a small gall-stone, about 3 mm. in diameter. If we recall the anatomy of the pancreatic ducts and the common bile-duct, we will find that in a large number of cases, perhaps 40 per cent., the duct of Wirsung joins the common duct in the ampulla a few millimetres above the papilla. In Opie's case the stone was large enough to occlude the opening of the common duct at the papilla, but not sufficiently large to, at the same time, occlude the opening of the duct of Wirsung. Inasmuch as Opie found the pancreatic ducts somewhat distended and bile-stained, he concluded that the small stone had occluded the opening of the ampulla of Vater into the intestine and had caused a retrojection of bile into the pancreas, the acute pancreatitis resulting; moreover, he showed that a typical acute pancreatitis could be produced in animals by the injection of bile into the pancreatic ducts, just as it had been shown by Flexner and others that the injection of various substances, such as artificial gastric juice, dilute acids, oils, etc., would produce an acute pancreatitis. The physiologic investigations of Pawloff and his pupils have shown that under normal conditions the pancreatic juice is inactive, but is activated by enterokinase, by

* Read before the Clinical-Pathological Society of Washington, D. C., May 1, 1917.

which trypsinogen is changed to trypsin. When this occurs within the gland digestion takes place and the enzymes are liberated into the gland and surrounding tissues, extensive necrosis resulting. Among other substances in the body, which seem to be able to activate the pancreatic juice, are: the duodenal contents, bacteria, blood serum and bile, especially when infected. Polya has called particular attention to the important part played by bacteria in activating the pancreatic juice in cases of acute pancreatitis.

Since the above case was published by Opie, several other cases have been reported in which almost identical conditions were found, and in one of my own cases a small stone was found occluding the outlet of the ampulla. Many cases have been reported in which acute pancreatitis has been associated with gall-stones in the gall-bladder and in portions of the common duct other than the ampulla. In a large series of cases of acute pancreatitis collected by Egdahl, gall-stones were found in 42 per cent. of the cases, and in 50 per cent. of a series of forty-four cases, reported by Körte, disease of the gall-passages was present. In 5 of my 7 cases gall-stones were found. In a certain number of cases the duct of Wirsung enters the intestine independently and does not join the common duct, and in such cases the presence of gall-stones is probably of little importance in the production of acute pancreatitis. Pancreatic stones are sometimes the cause of acute pancreatitis. According to Egdahl, gastro-intestinal disorders are, next to gall-stones, the most important cause of acute pancreatitis. In his series of cases, 32, or 30 per cent., belong to this group, and 17 of the 32 cases gave a history of alcoholism. He thinks that perhaps the gastroduodenitis may cause an occlusion of the papilla of Vater and a retrojection of bile into the pancreas.

Acute pancreatitis may be caused by a good many other conditions, such as typhoid fever, mumps, trauma, gastric ulcer, appendicitis, syphilis, etc. We do not wonder that typhoid fever may be a causative factor in the production of acute pancreatitis, as we all know the proneness of typhoid bacilli to lurk in the gall-bladder and bile-passages even many years after the attack of fever. Moynihan has recorded a case of acute pancreatitis in which typhoid bacilli were found in the pancreas. A good many cases have been reported in which mumps was complicated by acute pancreatitis, and this is not surprising when we consider the similarity in structure of the pancreas and the salivary glands; in fact, the pancreas is called by the Germans the abdominal salivary gland. In such cases the symptoms are usually milder than in other cases of acute pancreatitis and a good many have recovered without operation.

Although it is possible for bacteria to cause acute pancreatitis by activating the enzymes of the pancreas, they are probably in most cases secondary invaders. The organism most commonly present in acute pancreatitis is the bacillus coli communis, as we would expect, since it is a normal inhabitant of the intestinal tract; next in frequency are the streptococci and staphylococci. It is not definitely known how these organisms gain access to the pancreas, but it seems undoubtedly true that they sometimes pass

from the bile-passages into the pancreatic duct, sometimes directly from the intestine into the pancreatic ducts, sometimes by the blood-vessels and lymphatics, or directly through the intestinal wall into the pancreas.

Pathology of Acute Pancreatitis.—The pancreas, involved in acute pancreatitis, is usually found to be greatly swollen and its consistency is usually softer than normal, especially where the hemorrhagic infiltration and necrosis are extensive. It presents a dark reddish, mottled appearance, and, on microscopic examination, we find areas of necrosis, which stain poorly with the aniline dyes. About these necrotic areas there is a zone of inflammation and scattered through the involved gland there are more or less extensive areas of hemorrhagic infiltration. Sometimes the whole pancreas seems to be nothing but a mass of necrotic tissue.

There has been a good deal of discussion regarding the relationship between pancreatic apoplexy, the ultra-acute cases of Mayo Robson, and ordinary hemorrhagic pancreatitis, and the question is not yet definitely settled. Some think that hemorrhage can take place without previous inflammation, others think that inflammation always precedes the hemorrhage. It seems to me that in certain rare cases the hemorrhage may be due to the rupture of an arteriosclerotic vessel without previous involvement of the pancreas, but in most of these cases we are dealing with a very acute pancreatitis, the digestion of the vessel walls giving rise to the marked hemorrhage. Draper, of Boston, called particular attention to this so-called pancreatic apoplexy as a cause of sudden death.

The fat necroses which accompany acute pancreatitis are of considerable interest. It is now shown that they are due to the presence of the fat-splitting ferment, steapsin, in the tissues and Flexner has proved the presence of steapsin in these areas of fat necrosis. These areas present a peculiar yellowish-white appearance and are really areas of saponification as the neutral fat is split into glycerin and fatty acid, the latter combining with calcium in the tissues to form soap. They are of considerable importance, as their presence in the course of an operation always points to trouble in the pancreas.

The bloody fluid in the peritoneum in cases of acute pancreatitis has been considered by many to be quite toxic, and Guleke, who attributes its toxicity to the presence of trypsin, claims to have produced death in animals by its injection. On the other hand, this is disputed by Whipple, who has injected the fluid into the peritoneal cavity and veins of healthy dogs and dogs quite sick with acute pancreatitis, without producing any bad effect. He even believes that the exudate may neutralize the ferments and be beneficial, and thinks that operations undertaken with a view to draining it off are ill advised.

Symptoms of Acute Pancreatitis.—One of the most striking symptoms of acute pancreatitis is the acute agonizing pain in the epigastrium, which is so extreme that it may rapidly bring on collapse and may actually cause syncope. It is more or less constant but may be paroxysmal; it tends to remain in the epigastrium but may radiate to the left. Vomiting soon

occurs and is so persistent that, together with the obstinate constipation, it has frequently led to the mistaken diagnosis of intestinal obstruction. The constipation is almost absolute, though enemata may bring away a little gas. If the patient survives the acute stage and passes to the subacute, diarrhœa may follow the constipation. Distention of the abdomen is a prominent feature in this disease and first appears in the upper abdomen, as in one of my cases, where it seemed to be due to the direct effect of the inflammatory products upon the transverse colon; but later the distention becomes general. Tenderness is present in the upper abdomen, but the tenderness and rigidity are usually not extreme. The character of the pulse may be of value in the diagnosis of this disease, as it becomes rapidly weak and small. The temperature is not of a great deal of significance; it may be normal, subnormal or elevated to 103° or 104°. In the very acute cases it is apt to be normal or subnormal; whereas in the subacute cases it is likely to be high. Glycosuria as a symptom of pancreatic disease usually occurs late and with advanced destruction. It was found in none of my cases.

The various functional tests for disease of the pancreas are, generally speaking, not very satisfactory and are chiefly applicable in the chronic affections of the gland. The much discussed Cammidge reaction seems to be almost worthless, and the results of the estimation of the amount of diastase in urine in these conditions have proved rather disappointing. Crohn has recently studied the duodenal contents, removed by means of the Einhorn duodenal tube, in 120 cases, of which 17 had pancreatic involvement, and has also made careful metabolism studies on the fat and nitrogen absorption from the intestine in seven cases of pancreatic disease. The following are his very interesting conclusions:

1. The quantitative examination of duodenal ferments is the most rational and accurate method of studying the external secretion of the pancreas. Diminution of such enzyme activity of the pancreas is a reliable sign of organic disease of the gland. Occasionally, though rarely, a diminution of ferments occurs as a symptom of advanced organic disease elsewhere in the body. Roughly, the diminution of ferments is directly proportional to the extent of organic destruction which has taken place.

2. The absorption of fat and nitrogen from the intestine is independent of the condition of the external secretion, or even of its presence. Absorption may be poor with an intact gland, or good with a gland of which only a fragment survives the disease. The functional activity of the gland, not its organic condition, determines the degree of absorption; this is probably controlled by an internal secretion or hormone.

3. Duodenal ferment tests give the index of the organic condition of the gland. Absorption tests give the index of the functional activity of the pancreas.

Death usually occurs in from two to five days from collapse, though in the less acute cases life may be prolonged or recovery may even take place. There has been considerable discussion regarding the cause of death in acute pancreatitis. The theories of shock, due to the involvement of the solar plexus, and of sepsis do not hold. It has been shown that it is due to a toxæmia. For a time it seemed as though Hess were right, when he maintained that the toxæmia in pancreatitis was due to the formation of soap

and its absorption. By injections of oil and paraffin he produced a picture very similar to that of pancreatic apoplexy. This view was, however, challenged by Guleke and v. Bergmann, who showed by their experiments with implantation of the gland that the toxic substance is in the gland itself, apparently in the trypsin, for the commercial trypsin of Grübler had the same effect; moreover, they claimed that after previously immunizing an animal with trypsin, the production of pancreatic necrosis was not necessarily fatal. Doberauer, who in general holds this view, does not, however, think that the toxic substance is in the healthy gland, but that it is a product of the decomposition of the gland cells, caused by the self-digestion, which occurs in acute pancreatitis. It seems that Guleke and v. Bergmann now agree with Doberauer, and think that the toxæmia of acute pancreatitis is due to the absorption of the products of cell decomposition, caused by self digestion. Whipple thinks that a proteose intoxication is the most important factor in the general intoxication of acute pancreatitis, just as it is in intestinal obstruction.

Diagnosis of Acute Pancreatitis.—The diagnosis of acute pancreatitis is difficult, as the symptoms at first are only characteristic of a peritonitis beginning in the upper portion of the abdomen. It seems to me that this peritonitis is chemical and not infectious in the early stages of the disease. If we bear in mind the pancreas, when we meet with a stormy process in the upper abdomen, suggesting a perforative peritonitis or high intestinal obstruction, more cases of acute pancreatitis will be correctly diagnosed.

In general the differential diagnosis must be made from intestinal obstruction, and peritonitis, resulting from a perforated gastric or duodenal ulcer, a ruptured gall-bladder or appendix. The diagnosis is often impossible and is of consequence chiefly in regard to the nature of the incision as all of the above conditions demand operation. After the incision is made the presence of the serosanguineous fluid in the peritoneum and disseminated fat necroses clinches the diagnosis. However, a previous history of gastric disturbances with acid eructations or the vomiting of blood, together with extreme tenderness and rigidity in the upper abdomen, a rapid obliteration of the liver dulness, due to the presence of free gas in the peritoneal cavity, and perhaps a higher temperature and leucocytosis than in the usual case of acute pancreatitis, would indicate a perforated gastric or duodenal ulcer.

In case of intestinal obstruction the pain would probably be more paroxysmal in character, quite severe, but probably not so severe as that of acute pancreatitis, and whereas the collapse is rapid in acute intestinal obstruction it hardly comes on so rapidly as in acute pancreatitis. Moreover, on careful observation peristalsis will probably be seen in acute obstruction, whereas it is not present in acute pancreatitis, as here the obstruction is adynamic in nature. The history of the case, with a careful examination of the patient, will often permit us to distinguish between a peritonitis resulting from the rupture of an appendix or gall-bladder and an acute pancreatitis.

Subacute Pancreatitis or Pancreatic Abscess.—These conditions are of

especial interest, as they are particularly amenable to surgical treatment. They really represent the later stage of an acute pancreatitis which has probably had an onset just as acute as those which we have previously discussed, but, as a rule, the symptoms have not been so severe. The patient survives the acute attack, but he continues to complain of gastric disturbances, has more or less pain in the epigastrium, runs a temperature and gradually loses ground. Examination may show the presence of a tender tumor in the epigastrium.

Treatment of Acute Hemorrhagic and Gangrenous Pancreatitis.—Although the question as to the best treatment of acute pancreatitis has been freely discussed in recent years, it is not yet settled. Many surgeons are still averse to early operation, arguing that, inasmuch as the results of operative interference are more favorable after the formation of a localized abscess, one should wait until such an abscess forms before operating. This argument, however, is fallacious, as it does not consider the large percentage of those who die before such a favorable condition is presented; and, in the second place, many patients never develop a localized abscess, the process being diffuse from the beginning.

A number of surgeons, among them Körte, who formerly advised against operation in the early stages, now advise early operation. One of the first to advise operating in the first stages of acute pancreatitis was Hahn, who, considering the collapsed condition of most of these cases, recommended a small incision in the midline below the umbilicus and drainage for the evacuation of the blood-stained peritoneal fluid. He thought the high mortality after operation in such cases was, to some extent, due to the fact that the operation was undertaken with the mistaken diagnosis of peritonitis or intestinal obstruction, the prolonged search for the perforation or obstruction being badly borne by such weak subjects. This point has also been emphasized by Mikulicz and others. Woolsey, who has reported three cases operated upon in a manner essentially similar to Hahn's, with recovery, recommends laparotomy and drainage, and thinks extensive and prolonged operations are not justifiable. Pels-Leusden, Wiesinger, and others have reported cases thus treated successfully.

Halsted, Pels-Leusden and Bevan have reported cases of acute pancreatitis which recovered after laparotomy and closure without drainage. In some of these cases nothing more was done because the collapsed condition of the patient would not allow it. The benefit derived from these methods of operating has been thought to be due to the removal of the blood-stained peritoneal fluid, which has been considered very toxic, but, as stated above, Whipple has apparently proved that the effusion is harmless. Mikulicz in 1903 advanced the view that acute pancreatitis should be treated as any other phlegmon, and that the moment the condition is recognized the abdomen should be opened and the inflamed peripancreatic tissues and the pancreas itself incised and drained. He considered the flushing of the abdominal cavity with salt solution to be quite important. Porter and Muspratt have reported cases successfully treated by this method, deep incisions being made

into the pancreas and drainage instituted. A study of the literature reveals the striking frequency of the sequence of acute pancreatitis upon cholelithiasis, and a good many cases are recorded in which at the operation for acute pancreatitis gall-stones were found in the gall-bladder and cholecystostomy performed, the patient recovering completely.

I want to emphasize the importance of operating in the early stages of acute pancreatitis, before a secondary infection from the intestine renders the prognosis more unfavorable. Inasmuch as these cases are seldom diagnosed with absolute certainty and are often mistaken for peritonitis or intestinal obstruction, the operation will usually be in the nature of an exploratory laparotomy. The discovery of blood-stained fluid and the presence of fat necroses clinch the diagnosis.

The exact nature of the operation will depend upon the condition of the patient. The ideal procedure would be about as follows: Rapid exposure of the pancreas through the gastrocolic omentum, incision of the swollen, inflamed gland, and the introduction of a large gauze drain; examination of the gall-bladder and bile-ducts; removal of calculi, if present, and cholecystostomy. As a matter of fact, such a procedure may often be unwarranted and must be modified to suit the case.

Mikulicz in 1903 collected 46 cases of acute pancreatitis, which had been operated upon in the acute stage, with only 9 recoveries. On the contrary, 18 out of 35 cases recovered when the operation was done in the later stages. He states, however, very rightly that such statistics are of very little value, for, as he says: "First of all, we do not know from the statistics available at present how many of these patients with acute pancreatitis really survive the acute stage and go on to the subacute, the most favorable stage for operation. I believe that comparative statistics in this regard will show that the great majority of the patients die in the acute stage. The possibility that a goodly number could be saved by a rationally conducted early operation cannot at present be denied."

Bloodgood in 1904 collected 75 cases of acute hemorrhagic pancreatitis, of which 25 recovered and 50 died. Of the 25 which recovered, 18 had been operated upon, the remaining 7 recovering without operation. Of the 50 which died, 23 had been operated upon. Most recent statistics of operations for acute pancreatitis give the mortality as 50 to 60 per cent.

Körte in 1912 reported 44 cases of acute pancreatitis, of which 34 occurred in his own division in the Krankenhaus am Urban and also in his private practice, while 10 cases came from the second surgical division of this hospital and were seen and reported by Brentano. Of the 44 cases 38 were subjected to operation. In 6 cases no attack was possible. Of the 38 cases operated upon, the diseased pancreas was directly attacked in 34, while in 4 cases only the concomitant disease of the gall-passages received operative treatment. Of the 34 operated patients, in which the diseased organ was immediately approached, 18 recovered and 14 died, a mortality of 47 per cent. Of 12 cases operated upon in the first week after the beginning of the illness, 8 recovered and only 4 died.

Treatment of Suppurative Pancreatitis: Pancreatic Abscess.—Those cases of acute pancreatitis which proceed to suppuration, the subacute form of Robson and Moynihan, are of particular interest, since they are especially amenable to surgical treatment. In the majority of these cases the onset is as acute as in the hemorrhagic form, but the symptoms are, as a rule, less severe, and the process is not of sufficient extent and gravity to cause death. Somewhat later the necrosis and secondary infection give rise to the formation of more or less extensive abscesses, containing larger or smaller portions of the sequestrated pancreas. Considering the satisfactory results of prompt surgical intervention, the early diagnosis of these cases is very important, especially since grave complications are prone to arise, such as liver abscess, subphrenic abscess, thrombosis of the portal vein, exhaustion, etc.

Diffuse suppuration or abscesses confined to the pancreas are seldom seen, since the pus is very liable to burrow into the peripancreatic tissues and lesser peritoneum, often giving rise to a tumor, which can be more or less clearly defined before operation and which facilitates the diagnosis. The tumor usually presents in the midline below the stomach, but occasionally above the stomach, or it may extend over into the left flank, giving rise to the mistaken diagnosis of perinephritic abscess.

Spontaneous healing without operation is unusual, but cases where the diagnosis was confirmed have been recorded, in which recovery took place after the rupture of the pancreatic abscess into the intestine. Robson has reported such a case, and another in which the abscess ruptured into the stomach and recovery followed a gastro-enterostomy.

Cases of diffuse suppuration or small multiple abscesses offer little hope of successful surgical treatment, but with a large localized abscess the outlook is much brighter.

The diagnosis is often not determined until the abdomen is opened. The incision is usually made in the median line or through the rectus muscle over the most prominent part of the tumor mass. If the examination shows the presence of a pancreatic abscess, the abdominal cavity is packed off with gauze and the abscess opened, usually through the gastrocolic omentum, evacuated and drained with gauze or by means of a rubber tube surrounded with gauze. It is generally preferred to complete the operation in one stage, but it can be done in two stages, the abscess first being walled off with gauze or by suturing its walls to the parietal peritoneum and opened later, after adhesions have formed. To secure better drainage, especially when the abscess extends well toward the flank, it is sometimes advisable to make an incision in the costovertebral angle, and by blunt dissection, passing in front of the lower pole of the kidney, to open a path for drainage.

In recent years numerous cases have been reported in which recovery followed operations for pancreatic abscess. Thayer has reported 4 cases operated upon by Halsted, Finney, and Bloodgood, 3 of which recovered. Robson has reported 8 cases occurring in his own practice. Six were oper-

ated upon, with recovery from the operation in 5, though in 1 of the cases the relief was only for a few weeks and in another for a few months.

REPORT OF CASES

The following seven cases were operated upon in my service at the University of Virginia Hospital.

CASE I.—T. J., male, aged fifty-one years, was admitted to the hospital, April 29, 1909, complaining of abdominal pain and vomiting. *Family history:* Unimportant. *Personal history:* Owing to the urgency of the case very little of his previous history was obtained. He stated, however, that he used very little alcohol.

Present Illness.—Patient was taken sick suddenly, thirty-six hours ago, with severe pain in the epigastrium, where it remained twelve hours, then moved downward, but has never settled on the right side. He vomited shortly after onset of illness and has vomited frequently since. Bowels were obstinately constipated, but moved with the aid of large doses of salts and a big enema of olive oil. Patient says that he has suffered for the last few years with acid eructations, for which he has taken soda, but has never vomited except with headache. He has not vomited any blood.

Examination.—The patient, who is rather stout, looks ill. Pulse 132 to the minute, temperature 101 per rectum, leucocytes 20,000. Sclerotics are bile stained. The abdomen is considerably distended and the central portion is blistered by applications. On palpation there is some general abdominal tenderness, most marked around the umbilicus, though, according to his statement, eight hours ago it was most marked in the appendix region. No mass felt. Liver dulness reaches to within 3 finger breadths of the costal margin of the right nipple line. The urine was not examined. No definite diagnosis was made before operation, but an acute pancreatitis was suggested as a possibility, the pronounced shock in such a short time and the bile staining of the sclerotics strengthening this opinion.

Operation.—There was considerable trouble during the anæsthetization on account of vomiting of large quantities of black fluid. An incision was made through the upper portion of the right rectus muscle. A considerable amount of bloody fluid was found in the peritoneal cavity, which immediately suggested an acute pancreatitis. A piece of omentum was then sought for and found to be studded with fat necroses, clinching the diagnosis. The pancreas was palpated and found to be greatly thickened and poorly defined. No stones were felt in the gall-bladder or ducts. The patient's condition was so bad that it was not thought advisable to explore the pancreas, so an iodoform and protective drain was placed in the lower end of the wound, which was closed with through-and-through silkworm-gut sutures. At the end of the operation an intravenous infusion of salt solution was given, which improved his condition somewhat. The improvement was, however, only temporary, and he died six hours later.

Autopsy.—A complete autopsy was not allowed, but the liver, pancreas, duodenum, gall-bladder and ducts were removed through the

operative incision. The pancreas was everywhere enlarged to twice its normal size, presented a reddish mottled appearance, with marked hemorrhagic infiltration and areas of necrosis. The pancreatic ducts were not bile-stained and there was no stone in them. The gall-bladder was somewhat distended but no stones were found in the gall-bladder or ducts. There was a large amount of mucus in the duodenum, but no particular reddening of the mucosa. In this case, therefore, no definite etiological factor for the acute pancreatitis was discovered.

CASE II.—Mrs. M. S., aged fifty-five years, was admitted to the hospital May 26, 1909, complaining of attacks of pain in the right hypochondrium accompanied by nausea and vomiting. *Family history:* Unimportant. *Personal history:* Has had all the usual diseases of childhood. Had diphtheria when a girl and pneumonia fifteen years ago. Has never had typhoid fever, has been generally healthy except for her present complaint. She suffers somewhat from shortness of breath on exertion and her ankles are sometimes a little swollen. Menses began at twelve years of age and have always been regular. Has had two children. Labors normal.

Present Illness.—For twenty years she had irregular attacks of pain in the right hypochondrium. Last fall, seven or eight months ago, these attacks were unusually severe. They would come on suddenly, after some indiscretion in diet, would last from one to six hours and were usually accompanied by nausea and vomiting. The pain would begin in the right hypochondrium and radiate toward the umbilicus. Two months ago the attacks began again with equal severity and have recurred at frequent intervals to the present time.

Examination.—Patient is a well-nourished, healthy-looking woman, color good. No jaundice of sclerotics. Pulse good quality, 90 to the minute, temperature 100. Examination of lungs, heart and urine negative. The abdomen looks natural, no mass seen. On palpation a mass the size of an orange can be felt beneath the right rectus muscle, extending from the costal margin to the level of the umbilicus. The mass is smooth, rounded, slightly tender and descends little, if at all, on inspiration. The rest of the abdomen is negative. Liver dulness reaches the costal margin in the right nipple line. The mass was thought to be most likely a hydrops of the gall-bladder.

Operation.—Incision was made through the upper portion of the right rectus muscle. As soon as the peritoneum was opened it was seen that the mass, mentioned above, was not the gall-bladder, but was situated behind the gastrocolic omentum in the region of the head of the pancreas. The gastrocolic omentum over the mass showed numerous fat necroses, was adherent to the parietal peritoneum in places, and over the apex of the swelling had a dark discoloration. The mass, which was about the size of an orange, was smooth, elastic and actually fluctuant. A diagnosis of pancreatic abscess was made. The gall-bladder was palpated and found to contain a large stone, otherwise the gall-bladder seemed normal, not unduly distended. The gall-bladder was opened and a stone 3 by 4 cm. in diameter removed. Cultures were made from the bile and proved to be sterile. A rubber tube was sutured into the gall-bladder for drainage. The abscess was

opened at its most prominent part and a large amount of purulent fluid and necrotic tissue evacuated. A large rubber tube was placed in the abscess and gauze packed about it. The abdominal wound was partly closed with through-and-through silkworm-gut sutures. Cultures were made from the abscess and the staphylococcus aureus isolated.

Post-operative Course.—The patient did well after the operation but discharged considerable quantities of necrotic tissue. She was discharged from the hospital about one month after the operation in good general condition, but the fistula was still discharging somewhat and continued to do so for several months after she left.

CASE III.—M. K., male, aged thirty years, was admitted to the hospital September 12, 1909, complaining of severe pain in the abdomen. *Family history:* Unimportant. *Personal history:* Patient has had the usual diseases of childhood and, at the age of ten, a severe attack of diphtheria, from which his recovery was slow. Four years ago he had a bad attack of typhoid fever and about three years ago a frontal sinus abscess, for which he was operated. Since that time his health has been fairly good, with the exception of an occasional bilious attack. He has indulged in alcohol but not to excess.

Present Illness.—Began eighteen hours ago, with severe constant pain in the epigastrium, somewhat worse to the left. He vomited shortly after the onset of pain and has vomited frequently to the present time. Bowels have not moved in spite of frequent cathartics and enemata. He was brought in with a diagnosis of intestinal obstruction.

Examination.—Patient is a well-nourished man, seems to be in great pain, but does not look extremely ill. Color is good, no cyanosis, sclerotics are not bile stained. Pulse is of good volume and tension, 108 to the minute; temperature per rectum 99.6; leucocytes 16,000. Urinary examination negative. The abdomen is somewhat distended, especially in the upper portion. Respiratory movements are somewhat limited. No loops of bowel and no peristalsis seen. There is some general abdominal tenderness, which is quite marked in the middle of the epigastrium, but there is no definite rigidity or muscle spasm and no mass can be felt.

Operation.—Incision was made through the upper portion of the right rectus muscle. The transverse colon immediately presented in the wound and seemed somewhat distended. The small intestine was not distended and there was no sign of intestinal obstruction. There was a small amount of fluid in the abdomen, but it was not blood stained. There were numerous adhesions about the gall-bladder, but no stones were felt in the gall-bladder or ducts. The pancreas was palpated and found to be twice its normal size and rather firm. Numerous fat necroses were found in the gastrohepatic omentum, gastrocolic omentum and transverse mesocolon. The pancreas was exposed through an opening in the gastrocolic omentum, a small incision was made in the pancreas and a gauze drain placed down to it. The gall-bladder was opened and found to contain a considerable amount of very dark bile. Cultures were made from the bile and proved to be negative. A cholecystostomy was performed. This case, which is the earliest and

most favorable case of acute pancreatitis which the writer has ever seen, made an uneventful recovery and was discharged from the hospital October 10, 1909.

CASE IV.—Mrs. W. M., aged thirty-six years, was admitted to the hospital April 14, 1911, complaining of pain in the abdomen radiating to the back. *Family history:* Unimportant. *Personal history:* Has had measles, mumps and whooping cough. Had typhoid fever ten years ago. Has suffered with stomach trouble for eight years, manifested by vomiting and pain in stomach radiating to the back. Has had nine children, youngest being one month old.

Present Illness.—Patient gave birth to a child four weeks ago. Before the birth of the child she suffered from burning, cramp-like pains in the stomach, passing to the right shoulder, and these pains have become worse and continued to the present time. They have required frequent hypodermics of morphia. Six days ago she vomited a large amount of bile-stained material. At that time she was jaundiced. She had chills every night for a week after the birth of the child.

Examination.—Patient is a thin woman, looks sick. Sclerotics are distinctly bile stained. Pulse is of fair quality, 92 to the minute; temperature 100 on admission; leucocytes 9,200. Coagulation time four minutes. Urine analysis negative. The abdomen is flat and slightly asymmetrical, there being a fulness in the right hypochondrium. On palpation there is considerable tenderness in the epigastrium and right hypochondrium. No mass can be felt in the epigastrium, but in the right upper quadrant the edge of the liver can be felt, 5 cm. below the costal margin, and beneath this a rounded body, the size of a hen's egg, which feels like a distended gall-bladder. On inspiration it descends almost to the level of the umbilicus.

Operation.—Incision was made through the upper portion of the right rectus muscle. The gall-bladder was found to be considerably distended and numerous stones could be felt in it. The gall-bladder was aspirated and a large amount of bile obtained, which would seem to indicate an obstruction of the common duct rather than of the cystic duct. The gall-bladder was then opened and numerous small, faceted stones and one stone the size of a walnut removed. A careful examination of the common duct failed to reveal any stone. The pancreas was examined and the whole organ found to be greatly enlarged and fairly fixed in position. In places the limits of the gland were not well defined. In the transverse mesocolon near the pancreas there were several areas of fat necroses, suggesting a subacute pancreatitis. A large rubber tube was sutured in the gall-bladder and the abdominal wound partly closed.

Post-operative Course.—The patient did fairly well for a few days after the operation, then began to run a temperature and the pulse became more rapid. She died rather suddenly nine days after the operation.

Autopsy.—About a litre of blood was found in the abdominal cavity. Mesentery of the ascending colon infiltrated with blood. Head of the pancreas converted into necrotic, hemorrhagic mass. Numerous

fat necroses found. The pancreatic ducts were patent but a firm calculus 5 mm. in diameter was found in the ampulla of Vater.

CASE V.—Mrs. T. G., aged twenty-six, was admitted to the hospital, February 15, 1914, complaining of abdominal pain and vomiting. *Family history:* Patient has had two children, youngest seven weeks old, labor and puerperium uncomplicated. Last summer, nine months ago, she had two mild attacks, suggesting gall-stones.

Present Illness.—Ten days before admission patient was taken with severe pain in the upper right abdomen, was nauseated and vomited. Pain seems to have been confined to the gall-bladder region, did not radiate to the back or right shoulder. Following the subsidence of acute suffering there remained soreness and tenderness in the upper right abdomen. The pain persisted with varying intensity. Five days ago jaundice was first noticed, but it has largely disappeared. Until two days ago she had been up a portion of each day and during that time had little if any temperature. Two days ago she was seized with agonizing pain in the upper right abdomen requiring three-quarters of a grain of morphia for partial relief. Nausea and vomiting became pronounced and have persisted to this time. Bowel movement was obtained by use of cathartics, stools being very light colored.

Examination.—Patient is a well-nourished woman, but looks septic and very sick. Sclerotics are slightly bile stained. Temperature on admission 103.6; pulse 134, of rather poor quality; leucocytes, 20,800. Urine analysis negative. Abdomen is quite distended, symmetrical, no mass seen. There is some general abdominal tenderness, but tenderness is much more marked in the epigastrium and right hypochondrium. There seems to be an indefinite resistance in the right side of the epigastrium, but no mass can be felt. Abdomen is everywhere tympanitic. Liver dulness reaches the costal margin in the nipple line. The patient was thought to have a gangrenous cholecystitis.

Operation.—Incision was made through the upper portion of the right rectus muscle. On opening the peritoneum a considerable amount of yellowish fluid escaped, and it was thought that the gall-bladder might have ruptured, but the gall-bladder was found in fairly good shape, though its walls were slightly thickened and it contained a number of small stones.

Further examination revealed numerous disseminated fat necroses distributed widely throughout the omentum and transverse mesocolon. A large mass was found in the region of the pancreas. The lesser peritoneum was opened and a considerable amount of chocolate-colored fluid evacuated. Incisions were made through the peritoneum covering the pancreas and a considerable amount of the same kind of fluid evacuated. The whole pancreas was thickened but it was not as soft as it often is in cases of acute pancreatitis. Small incisions were made into the pancreas and cigarette drains placed in these openings and in the peripancreatic tissues.

The gall-bladder was opened and about twenty small mulberry stones, 2 to 5 mm. in diameter, removed. The bile was very dark and somewhat thicker than normal. Rubber tube was sutured into the gall-bladder for drainage. Considering the character of the stones and

the fact that the patient gave a very definite history of a fairly intense jaundice a few days before admission, it was thought that one of these stones had at one time occluded the opening of the diverticulum and caused a retrojection of bile into the pancreas. This represents a fairly acute case of pancreatitis.

Post-operative Course.—Convalescence was very tedious. Temperature remained somewhat elevated for several weeks. About eighteen days after operation patient became nauseated and vomited without ascertainable cause. From this time until her discharge she had vomiting attacks, sometimes daily, at others at intervals of two to six days. Aside from this feature the last two months of her stay in the hospital were passed in remarkable comfort. The fistula discharged freely for some time, large pieces of necrotic tissue (pancreas) coming away at times. The skin about the fistula was considerably excoriated by the pancreatic discharges. The patient remained in the hospital eighty-one days after the operation and was still quite weak when she left, but I learn from her doctor that she is now perfectly well.

CASE VI.—Mrs. J. A. H., aged forty-eight, entered the hospital February 17, 1916, complaining of stomach trouble. *Family history:* Unimportant. *Personal history:* Has never had typhoid fever. Had pneumonia nineteen years ago. Has suffered with "indigestion" for years. Has had four children, no complications during labor or puerperiums.

Present Illness.—About a year ago she had a severe attack of epigastric cramp, mainly upon the *left* side. Pain was intense, lasted about six hours. Since then she has at irregular intervals had similar attacks, sometimes with vomiting, sometimes without. There has been little if any temperature. Preponderance of pain has been in the left epigastrium, some, however, in the upper right abdomen with occasional radiation to the back. She has never vomited blood. Her last attack, which was very severe, occurred the day before admission and lasted about six hours.

Examination.—Patient is moderately nourished, appears rather weak. Sclerotics distinctly jaundiced. Temperature 100; pulse 100, fair volume and tension. Urine examination shows a trace of albumen, no sugar. Abdomen is flat. No visible masses. There is tenderness across the whole upper abdomen, especially in the midepigastrium and a few inches to the left. No masses felt. Liver dulness reaches the costal margin in the right nipple line. A diagnosis of gall-stones was made.

Operation (April 20, 1916).—A high right rectus incision. On opening the peritoneal cavity no free fluid was noted. The gall-bladder was found to be somewhat thickened and to contain gall-stones. Numerous fat necroses were found in the omentum and peritoneal fat. The pancreas here was markedly thickened and firm throughout. No stones could be made out in the common duct. One large and several small, mulberry stones were removed from the gall-bladder and cholecystostomy done. The pancreas was not drained.

This seems to be an example of an acute exacerbation of a chronic pancreatitis.

Post-operative Course.—Patient had an uneventful convalescence. Wound healed nicely. General condition good at time of discharge, four weeks after operation.

CASE VII.—Mrs. J. H. H., aged forty-eight, was admitted to the hospital April 8, 1916, complaining of pain in the stomach *Family history:* Unimportant. *Personal history:* Patient has been having attacks similar to the present one for the last five or six years, coming on at intervals of several months and often lasting for several days, but none has been as severe as this one. No history of previous jaundice, chills or fever. Bowels somewhat constipated and stools of yellow color. No urinary disturbance. She is the mother of eight children.

Present Illness.—About ten days before admission patient was seized with severe cramp-like pain in the epigastrium, radiating to the back, more to the *left* and also down into the lower abdomen. She suffered much pain and vomited almost continually for a number of days. Pain has been almost constantly present since onset. Says she has been very tender in upper abdomen.

Examination.—Patient is a rather stout woman. General condition seems fairly good. Skin is slightly yellow and sclerotics are definitely bile stained. Temperature 101; pulse 90, of good quality; leucocytes 15,000. Urine analysis negative. Abdomen is not distended. There is considerable tenderness in the gall-bladder region and as far down as the appendix region. There is some tenderness in the epigastrium and to the left. No masses felt. Liver and gall-bladder not felt. No dulness.

Operation (April 10, 1916).—High right rectus incision. No free fluid in peritoneal cavity. The omentum was found adherent to the gall-bladder and showed numerous patches of fat necrosis. The gall-bladder was moderately distended and contained one large stone without facets. There was considerable induration around the common duct, but no stones could be felt in it. The pancreas was much thickened and indurated throughout its extent. A rubber tube was sutured into the gall-bladder and iodoform gauze packed around the gall-bladder and toward the foramen of Winslow.

Post-operative Course.—Patient did fairly well for four or five days after operation. She then became more deeply jaundiced, began vomiting. Wound broke down throughout and discharged bile and a thin brownish fluid. Vomiting became persistent. Pulse became rapid and weak. Temperature which had been elevated since admission gradually rose and during the last days ranged between 104 and 106. She died sixteen days after the operation.

Autopsy.—A post-mortem examination was made and revealed a subdiaphragmatic abscess, extensive fat necroses in the great omentum, mesentery, subperitoneal fat and about the liver and right kidney. The pancreas was adherent and was dissected out with difficulty. Its head was entirely necrotic, leaving nothing but a blackish debris. Its body and tail were intact, but quite hard and showed nothing unusual on section. Pancreatic duct necrotic and could not be found. No obstruction found in the common duct.

ACCESSORY PANCREAS WITH INTUSSUSCEPTION

By Arthur E. Benjamin, M.D.
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In "Diseases of the Stomach and Intestines," R. C. Kemp states that "Accessory pancreas is a mass of pancreatic tissue entirely separate and having its own duct; may assume the function of the main organ when diseased and may cause diverticula or herniæ of the wall of the intestines."

Opie reports 10 cases in 1800 autopsies, dividing them into two groups, viz., those lying above the pancreas in the duodenum and stomach and those in the duodenum and jejunum.

Accessory pancreas has also been found in the ileum, in an umbilical fistula, in mesentery of duodenum and in fat of great omentum. The aberrant pancreas averages 1 cm. in diameter though it has been 4.5 cm. More than one may be found in the same person. About one-third of these glands are situated in the wall of the stomach in the submucosa near the pylorus and about two-thirds occur in the intestinal wall and more frequent in the muscular layer. The tissue of an aberrant gland is not different from normal pancreas in histologic features. The pathological changes affecting accessory pancreatic tissue are fat necrosis, chronic interstitial inflammation and malignant growth.

A number of cases are recorded in which accessory pancreas is associated with diverticulum of intestines occurring in the jejunum, ileum, duodenum and once even in the stomach side. A diverticulum usually occurs in children from less than a year to fourteen years of age. "The results of these diverticulæ are intestinal obstruction, acute intraperitoneal inflammation, hernia into the pancreas with or without hemorrhagic necrosis."

Dr. G. F. Ruediger states in the *Journal of the American Medical Association*, 1903, that accessory pancreas may sometimes be a causative factor in the production of diverticulum of the intestine by exerting continuous traction on the intestinal wall, during development; or it may at any time become the starting point of a carcinoma. This has, however, never been observed. If the swelling protrudes into the lumen of the bowel and attains a considerable size, it might produce some obstruction to the movement of the intestinal contents, or perhaps it might cause an intussusception by continuous traction on the inner surface of the intestinal wall, from the passage of the contents over it.

Dr. Aldred S. Warthin reported in the *Physician and Surgeon*, 1904, page 338, the following statistics of the location of accessory pancreas: Wall of stomach, 14; wall of duodenum, 12; wall of jejunum, 15; wall of ileum, 1; wall of intestine, 1 (not definite); diverticulum of stomach, 1; diverticulum of jejunum, 1; diverticulum of ileum, 4; Meckel's diverticulum, 1; umbilical fistula, 1; mesenteric fat, 1; omentum, 1; 53 (49 cases).

CASES REPORTED IN JEJUNUM

1 (1859).—Reported by Klob: location, posterior wall of jejunum. Numerous small ducts. No excretory duct.

2 (1860).—Reported by Montgomery: location, upper part of jejunum beneath the serosa, one inch in diameter. Microscopical structure, identical with that of pancreas, no duct.

3 (1861).—Reported by Zenker: location, first coil of jejunum close to the duodenum. Microscopical structure, identical with that of pancreas. Excretory duct opening into intestine.

4 (1861).—Reported by Zenker: location, first coil of jejunum close to duodenum. Microscopical structure, identical with that of pancreas. Excretory duct opening into intestine.

5 (1861).—Reported by Zenker: location, first coil of jejunum 16 centimetres from duodenum. Microscopical structure, same as that of pancreas. Excretory duct opening into intestine.

6 (1861).—Reported by Zenker: location, two accessory glands, one 16 centimetres, the other 48 centimetres from duodenojejunal junction. Both in submucosa. Microscopical structure identical with that of pancreas. Excretory duct opening into intestine.

7 (1896).—Reported by Hanseman: location, in tip of diverticulum of upper portion of jejunum. Not described.

8 (1900).—Reported by Nicholis: location, in wall of beginning jejunum. Projecting into lumen. Microscopical structure, multiple lobules. Small excretory duct.

9 (1903).—Reported by Opie: location, in submucosa of jejunum, 11 centimetres below duodenum, opposite the mesentery. Pancreatic tissue in bile papilla. Microscopical structure resembles an adenoma. Contains centro-acinar cells. Interstitial inflammation. Islands not mentioned. Tubular structures resembling ducts. Excretory duct not determined.

10 (1903).—Reported by Opie: location, in submucosa of jejunum, four metres from duodenum. Microscopical structure, ducts resembling those of pancreas. No acini, dense fibrous stroma. Excretory duct not determined.

11 (1903).—Reported by Ruediger: location, in muscular coat of wall of jejunum, 15 centimetres from duodenojejunal junction. Microscopical structure identical with normal pancreas. Numerous small ducts. Typical islands of Langerhans. Large duct opening into intestine not positively demonstrated.

12 (1903).—Reported by Thorel: location, mass 2.8 centimetres long, thickness of the little finger, in wall of middle of jejunum. Marked prominence on both mucous and serous surfaces. Microscopical structure: made up chiefly of complicated system of ducts lined by columnar cells. Pancreatic acini, but no islands of Langerhans. Excretory duct followed to mucosa. Opening not determined.

13 (1903).—Reported by Thorel: location, middle of jejunum. Partly covered by atrophic mucosa, somewhat smaller than a pea. Microscopical structure of an adenomyoma. No pancreatic parenchyma. Three excretory ducts.

14 (1903).—Reported by Thorel: location, middle of jejunum. Partly covered by atrophic mucosa. Somewhat smaller than a pea. Microscopical structure of an adenomyoma. No pancreatic parenchyma. One excretory duct.

15 (1903).—Reported by Thorel: location, two accessory nodules of pancreatic tissue, one in the wall at upper third of jejunum, the second about three finger breadths from this, embedded in the mesenteric fat. The intestinal one 3.2 centimetres long by 1.2–1.8 centimetres in diameter; the mesenteric the size of a two-mark piece and 1 centimetre thick. Microscopical structure; between circular and longitudinal muscle coats. Both identical with normal pancreas. Numerous islands of Langerhans. No excretory ducts found in either nodule.

16 (1913).—Reported by Short: Causing acute pancreatitis and excited acute inflammation of the muscular coat of the surrounding jejunum producing considerable obstruction, incessant vomiting, slimy diarrhœa and melæna.

17 (1908).—Reported by T. Carwardine: In all of jejunum, two inches from duodenojejunal flexure, about size of filbert.

Personal Case (BENJAMIN).—White, German, 39 years of age; farmer last three years, blacksmith previous to that time. Best weight, 171 pounds; average weight, 160 pounds. Weight three weeks ago, 120 pounds, still losing. Loss of weight has been constant since January 20 last (three months ago).

Family History.—One sister died of T. B. (pulmonary) 18 years ago. No familial disease.

Past Illnesses and Injuries.—Kicked by a horse fifteen years ago in the thigh, a tumor the size of a hen's egg from this region was removed thirteen years ago. Pneumonia twice, last time six years ago, no complications. Four years ago had some cough during winter, expectorated blood, not laid up. Last winter (in early part) had mild cough and expectorated considerable blood. Blood was bright and frothy. Not laid up from work.

Present Illness: Fifteenth of January, 1917, began having difficulty in passing urine. Had to urinate six or seven times during the night, very small amount at a time. No blood; at the same time began having severe pain in the lower part of abdomen which extended over into left side, at times pains were sharp and "stitchy" and lasted a couple of minutes. No particular relation to urination. Since then (for the last two months) pain has been located in upper right quadrant, of different character than that which began in January, being heavy and "grinding and very weakening." Starts in upper right side and moves over to region of umbilicus. Had "rolling, bubbling" sensation in right side which seemed to have moved toward stomach.

For the last two months has had vomiting spells, for first month spells occurred once a week, but of late the spells have increased in frequency to every two or three days. Emesis has always been very large in amount (1–2 quarts). Dark green and bitter. No blood nor undigested food particles. Taking of food never distressed him, nor have they had any relation to the vomiting spells.

Vomiting attacks came on without pain or effort, "simply flowed out," as patient said. Attacks occurred night or day and without warning, they always seemed to relieve pain in the right side.

Stools never constipated. Began to be black January 15, 1917, at time that his present illness commenced. Stools black for last three months, with exception of last three weeks when they have had their natural color. Never had nose bleed nor bleeding from gums. First of the year patient noticed that he tired more easily and legs felt weak. Tired feeling became progressively worse and during last two months has been very weak. Noticed that his skin began to get very pale the last of January. Feet never became swollen, never swollen under eyes, never bloated.

For last week has been expectorating considerable muco-purulent material.

Laboratory Findings.—Urine, normal. Blood, hæmoglobin 50 per cent.; leucocyte count, 11,000. Gastric analysis, Ewald test meal, aspirated in one hour. Amounts, 250 c.c. yellow, some brown and coarse particles, mixed with mucus, sour odor, bile tinged. Free HCl, 10. Total acid, 40°. Lactic acid, trace. Blood, trace. Microscopically, nothing of importance.

Sputum showed no *B. tuberculosis*, pneumococcus predominant. Essential points in fluoroscopic examination of stomach: showed marked hyperistalsis, with occasional spastic contractions, pylorus open, duodenal cap not distinct.

Each pyloric contraction was immediately followed by a marked bulbous dilatation of the third or horizontal portion of the duodenum (dilatation attained the size of the stomach, presenting a very impressive appearance).

Sixth Hour Examination.—Some residue in stomach, marked dilatation of the duodenum as above. Patient was allowed to eat at this time by mistake.

Ninth Hour Examination.—Small intestine empty. Tenderness over hepatic flexure, appendix visible, cæcum free.

An exploratory operation was performed at the St. Barnabas Hospital April 21, 1917, the patient taking about 3½ oz. of ether. The operation was begun at 9.50 A.M. A median incision was made above the umbilicus. No gall-stones were found, the pylorus was patulous, but there were adhesions extending across the pylorus and pyloric end of the stomach. There were some signs of perigastritis. The cæcum was dilated, the appendix normal. The mesentery of the ascending and transverse colon brings these sections closely together. The sigmoid was redundant but not dilated. There was an intussusception of the upper part of the jejunum beginning about eight inches from the ligament of Treitz involving about a foot and a half of the jejunum. This was reduced and found to contain a tumor-like mass involving the jejunum about 10 inches from the ligament of Treitz, this tumor-mass being about $2 \times 1\frac{1}{2} \times 1$ inch with inverted portion of bowel and one inch square ulceration of the serosa (see Figs. 1, 2, and 3). This ulceration may have been due to interference with the circulation on account of the intussusception. It was thought best not to remove the growth, owing to the obstruction at this point and the weakness of the patient, but a side-to-side anastomosis was made of the jejunum above and below this mass, the portion below being much dilated, having enveloped the tumor-mass by creeping upward and around it. The anastomosis was made with linen (Pagenstecher) 2 rows loosely drawn, on account of the friability of the tissue about the tumor; these sutures were supplemented by fine chromic catgut outside. The omentum was stitched down on to and over the line of sutures and a tube put down to it for drainage. The stomach wall was somewhat fibrous. The peritoneum was closed with plain catgut No. 2 double chromic double No. 1 for fascia and the skin with chromic No. 1 single. The operation was completed at 10.55 A.M. Pulse before operation, 90; pulse during operation, 90–128–124; pulse after operation, 100. Blood-pressure under anæsthesia before operation, 128; blood-pressure under anæsthesia after operation, 100.

A hypodermic of morphine, gr. 1/6, with atropine, gr. 1/150, was given at 8.30 A.M. before the operation.

April 25, 1917: Has been vomiting some since operation, pulse very weak, stomach washed, vomiting ceased, pulse continued rapid. Bowels loose, unable to retain saline solution. Investigation of wound showed an opening below the tube with a separation of the skin and muscle tissue but scarcely any discharge. Further investigation found the peritoneum and muscle layer had separated completely owing to defective suture or rapid absorption, more likely the former. The wound was immediately stitched under local anæsthesia with interrupted silkworm-gut sutures extending through the skin, muscle and

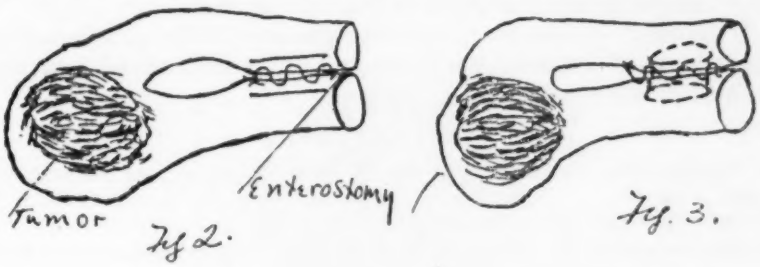

Fig 2. Fig. 3.

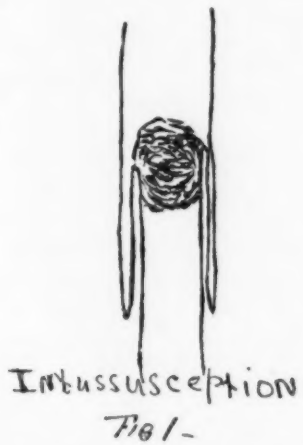

Fig 1.

peritoneum, crossed and tied over rubber tubing. About eleven sutures were used in all. Very little pain was experienced, a hypodermic being previously given. The patient felt better after the closure of the abdomen. The intestines looked healthy, not distended but somewhat adherent around the wound.

Patient did fairly well for a few hours but died April 26, 1917, probably due to inanition and shock, not having had any nourishment to speak of for three or four weeks, as he had vomited and had become greatly emaciated.

The tumor which was removed was 3 × 4 × 3 cm. A cauliflower-like mass projects from the mucous membrane by a stem a short distance from the duodenojejunal junction. The pulling by the stem of

the intestinal wall together with the growth causes a partial obstruction and an initial step of the intussusception. The tumor-mass is hard and friable and appears typically carcinomatous (Fig. 4).

Microscopic sections show mucous membrane intact except for slight inflammatory changes and occasional infiltration of the tumor cells. The compact mass of tumor cells arranged within alveolar mesh work is primarily located in the submucosa with occasional areas of downward infiltration into muscularis.

Cells uniform in size with no mitosis are granular, giving the appearance of its secretory nature. There are found no secretory ducts, no areas corresponding to those of Langerhans. The structural appearance microscopically, otherwise, is that of pancreas.

Diagnosis.—Adenoma of accessory pancreas. The question of malignancy is still disputed, mainly because of the evidence of downward infiltration into muscularis.

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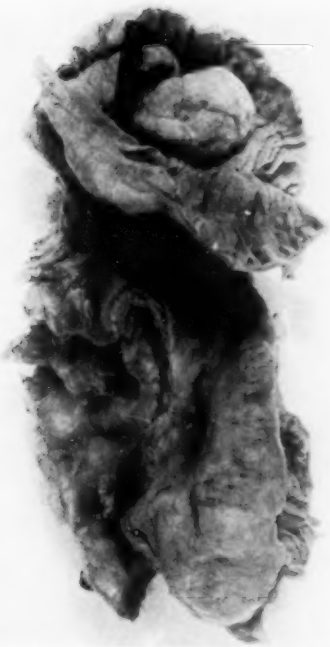

FIG. 4.—Tumor caused by degenerated accessory pancreas.

SPLENECTOMY IN SPLENOMEGALIES*

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For no other of the viscera as for the spleen has the minute study of the functional co-relation of that organ to the remainder of the bodily economy brought so many practical surgical applications.

Accomplished for the first time by an Italian surgeon, Zaccarello, in 1549, for a malarial splenomegaly (so says Fioravanti in his *Tesoro della vita Humana*), splenectomy had been reserved over a long period of years for cases of hernia of the spleen through parietal abdominal wounds (cases reported by Viard, Mathias and others). And from this date, we must pass to 1826 before finding that a diseased condition of the spleen incited surgical intervention and removal of that organ (Quittenbaum's case). This concept led to the splenectomy undertaken by Kuchler (1855) and Spencer Wells (1865) with, however, fatal issue. It would appear from the literature that the merit of having first accomplished a successful splenectomy belongs to Pean (1867), who, it is said, also established the fundamental rules governing surgical intervention in cases of splenomegaly. From this time on it gradually became more and more the current practice to extirpate the spleen in strictly surgical conditions, such as neoplasiæ and animal parasitic accumulations. Finally, when pathological research upon the hæmopoietic apparatus and the glands of internal and external secretions accentuated the value of the splenic factor in a number of abnormal conditions of the blood and glandular systems, numerous lesions of the spleen which had been theretofore characterized as dominantly medical considerations were pronounced surgical conditions; and thus Vulpius (1893) reports upon 121 splenectomies; Bessel-Hagen (1900), 218 splenectomies; Johnston (1908), 708 splenectomies.

Splenomegaly is a clear concept; it deals with an inherent increase in the volume of the spleen exclusive of certain pathological entities, such as abscesses, parasitic cysts and tumefactions incident to acute infective proc-

* In March, 1916, it was my privilege to assist at a splenectomy done by Dr. Paul Pilcher, who then asked me to gather whatever literature I could relative to the prognosis of splenectomy in splenomegalies, with the view of making a chemical survey of the blood to determine, if possible, what relation the spleen bore to the etiological pathogenesis of certain forms of essential anæmias. I have only recently completed a collection of American and Continental monographs bearing on this subject, the delay having been occasioned by faulty delivery of transatlantic correspondence incident to the war. I now offer my manuscript for publication in the Annals of Surgery, in memory of Dr. Paul M. Pilcher, whose keen insight into matters pathological has awakened in me a new vision of the field of pathology, and has inspired me to new inquiries along this most fruitful line.

esses, and lastly, those chronic intoxications and circulatory disturbances which occasion "amyloid" spleen and "cardiac" spleen (Banti). Splenomegaly deals with: (1) Infantile splenomegalic anæmia; (2) Griesinger type splenic anæmia; (3) Banti's disease; (4) Vaquez's disease; (5) Gaucher type splenic anæmia; (6) chronic splenomegalic hæmolytic jaundice; (7) leukæmia and pseudoleukæmia; (8) pernicious splenomegalic anæmia.

To these may be added the splenomegalies incident to: (9) Primary tuberculosis of the spleen; (10) splenic syphilis; (11) malarial spleen; (12) infection with Leishmann's spirillum.

Infantile Splenomegalic Anæmia.—Omitting a discussion of the histopathology and minute clinical manifestations of this disease, it suffices to record here as infantile splenomegalic anæmia, studied by Cardarelli, Fede, von Jaksch, Luget, Sternberg, Mya and others, that progressive anæmia found among children which terminates fatally usually before the first year, seldom reaching the second year of life, and has its course characterized by a considerable enlargement of the spleen. Bearing in mind that the spleen exerts a hæmapoietic function, but also a hæmocatatonic, if not an actual hæmolytic activity, the conception of treating the disease surgically by splenic extirpation was early entertained. DeRenzi induced Salvia so to intervene and reported eminent success in one case. Buren, Knott and Beccherle were equally successful. Wolff and Graff, however, were unsuccessful in that the complete clinical syndrome returned one year following removal of the spleen in the case reported by them.

It would seem advisable to follow the recommendation of DeRenzi in this condition, more especially when we consider how futile is recourse to therapy in this disease (iron, arsenic, antiluetic treatment, etc.).

Griesinger Type Splenic Anæmia.—Gretzel in Griesinger's clinic at Berlin (1868) proposed the term splenic anæmia in describing the case of a child who on examination was found to have quite a large spleen attended with some enlargement of the liver and lymph-nodes, though examination of the blood showed the absence of leukæmia. Krumbhaar wisely indicates that a term like "splenic anæmia," which we now believe to include several distinct types, should properly be restricted or discarded entirely; and, while accepting Krumbhaar's opinion, the fact is reported that Banti invited Colzi to perform a splenectomy upon a case diagnosed splenic anæmia, the result, however, being lost to literature.

Banti's Disease.—It would seem that the results of splenectomy show to their best advantage when surgery is practised in Banti's disease before hepatic cirrhosis has developed (second period) or ascites begun (third period); in other words, during the first period when only anæmia and splenic enlargement exist. Banti holds that the causative agent, perhaps infective, is first localized to the spleen where splenotoxins are elaborated and from whence they circulate, giving rise to anæmia and cirrhosis of the liver—a chronic interstitial hepatitis of splenic origin—just as alcohol occasions a chronic hepatitis, though of gastro-intestinal origin. The enlarged

spleen does not appear to show anything especially distinctive beyond a general fibrosis and a marked adenoid structure, the so-called "*fibroadenie*" of the French.

In the first period, extirpation of the spleen including the toxic *locus* is followed by prompt and complete cure (Banti). In fact, whereas cases of splenomegaly due to Banti's disease terminate fatally when consigned to medical care alone, in those cases operated upon by Colzi at Banti's request the report showed 100 per cent. recovery in two cases during the first period; 66⅔ per cent. recovery in three cases during the second period; and death in one case during the third period. In a second series including 11 cases, Banti reports about the same proportion of recovery to the period of the disease. The following statistics would confirm Banti's view:

Reported by	Year	Cases	Deaths	Per cent. mortality
Bessel-Hagen	1900	16	3	18¾
Armstrong	1907	32	9	28
Torrance	1908	36	10	28
Johnston	1908	61	12	19½
Muhsam	1914	29	5	17
Criscenzi-Rossi	1915	15	4	26⅔

Bret and Cordier (1911) summarize their findings as follows: Mortality in first period operations, 25 per cent. Mortality in second period operations, 40 per cent. Mortality in third period operations, 60 per cent. It is noteworthy to add the experience of Roch who, of 13 cases of Banti's disease wherein a splenectomy was done, the cases having progressed to the third period and marked by pronounced hepatic cirrhosis, reported but 4 deaths; and these figures agree with the favorable reports of Quenn, Duval, Humber, Berard, Zancan and Thial. Carre, Jaffe, Levison and Thole all report success following splenectomy in Banti's disease and strongly advocate surgical intervention.

Vaquez's Disease.—This most rare affection which had been described before Vaquez by Widal and Render is characterized by its threefold symptomatology, splenomegaly, anæmia and cyanosis. Its pathogenesis is the subject of much discussion and uncertainty. Equally uncertain is the therapy. Schneider, Cominotti and Jedlick endeavored in vain to secure a remedy through the practice of splenectomy, but they all three reported complete failure. It is being more and more conceded that this type of splenomegaly is not a distinct entity, but belongs to one of the other described types of splenic anæmia.

Gaucher's Disease.—Whether this form of anæmia with splenic involvement is to be considered a true splenic tumor (endothelioma) or a generalized hematopathy with splenic localization, still remains a matter of dispute. Gaucher spoke of a splenic epitheliomatous condition, which conception was shared by Picon and Rammond. Then it was noticed that the pathology involved either the endothelial elements of the spleen (Bovaird) or the

supporting parenchymal interstitial tissue (Schlangenhaufer). Other observers soon reported that the condition was not indigenous to the spleen but is met in the liver, certain groups of lymphatic glands, and in the osseous marrow (Brill, Marchand, Mandlebaum, Knox, Whol, Hermann). If the latter pathology were correct, it would seem that splenectomy were contraindicated. Yet Chavannez and Gujot report 4 cases of the Gaucher type anæmia where splenectomy was done and a cure obtained. Giffin reports three cases with three cures, but it is doubtful if two of the cases reported are typically of the Gaucher type splenomegaly. Contrary to the teachings of the surgeon Silvestrini, one should feel no hesitancy in performing a splenectomy in this type of anæmia.

Chronic Splenomegalic Hæmolytic Icterus.—Two types of this form of hæmolytic jaundice are recognized: (1) The congenital type of Minkowski-Chauffard; (2) the acquired type of Hayem-Widal. Thayer groups both types under the heading hæmolytic jaundice, and Tillston under the heading chronic family jaundice. Krumbhaar, following the continental custom, favors the distinction into two groups; and since both types are quite characteristic and distinctly pronounced, the dual classification should be retained.

It was held for considerable time that the origin of these hæmolytic icteric forms of splenomegaly was inherent in the liver, more precisely, in the particular functional and congenital alteration of the hepatic cell (Pick), or, infective angiocholitis (Loevy, Hayem and Strauss) favored, according to Gilbert, by a morbid hereditary predisposition of the biliary canals. At this time, however, Widal, Marchiafava and Nazzari claim that the fundamental pathology of the conditions lies in a lesion of the blood which is both chronic and destructive. The fact remains that in the splenectomies reported by Bland-Sutton, Colzi, Micheli, Oliva, Fiori, Bastanielli, Ranzi and others, and including both classifications of hæmolytic jaundice, 5 deaths in 48 cases followed.

Leukæmia and Pseudoleukæmia.—It is not certain to what extent the existing theories relative to the pathogenesis of the leukæmias have occasioned the surgical therapy of splenectomy in these morbid conditions. Whether one adheres to the neoplastic theory of Bard and of Banti, or to the theories of Ehrlich or Neumann, it is generally conceded that the entire hæmatolymphopoietic system participates in the various lymphoid, myeloid and cellularplastic transformations that characterize the various forms of leukæmia and pseudoleukæmia (comprising the splenomegaly with myelocytæmia of Weil and Clerc and the myeloid splenic anæmia of Vaquez and Anbertin). Certain it is that in the pathology of these morbid processes, the spleen does not occupy either an exclusive or predominating rôle; and the extirpation of that organ has not been recorded as benefiting the disease.

This view is borne out by the surgical experiences of Vulpius, who in 28 cases of splenectomy in leukæmic enlargement of the spleen had 25 deaths; Bardenheuer, in three cases had three deaths; Franzolini reported a complete cure, but strict scrutiny of the history of the case would indi-

cate that the disease was a Banti's splenomegaly, not a leukæmia of any sort; Vanvers had 26 deaths in 29 cases; Bisset-Agen, in a series of 42 cases of splenectomies for leukæmic tumefaction of the spleen, had only 4 recoveries, of which 2 ultimately died of the primary leukæmic involvement. The statistics of Legnani show 5 deaths in 6 cases; those of Johnston, 43 deaths in 49 cases. Giffin reports one case in which the diagnosis was not certain; the patient remained well for five and one-half years, after which time the leucocyte count increased to 64,000, with 14 per cent. myelocytes.

Some success was reported by Hartmann, Penginez and Julien, Kuttner and Pimentel. For about an average of three years following splenectomy, these observers reported beneficent results; but at the end of that time, a cachexia develops which runs to a rapidly fatal end.

In general, splenectomy is not followed by favorable results in splenomegalic conditions incident to leukæmia or pseudoleukæmia.

Pernicious Splenomegalic Anæmia.—Some cases of so-called pernicious anæmia develop an extreme tumefaction of the spleen. This led Empiger to believe that the spleen was the seat of an exaggerated pathological destruction of red cells, and he, Empiger, having had considerable good fortune with splenectomy in cases of hæmolytic jaundice, conceived splenectomy as a measure to be adopted in this form of anæmia; and in 1913, together with Exner, Empiger communicated successful splenectomies in cases of pernicious anæmia.

Just previous to this time Banti had recommended splenectomy in cases of progressive pernicious anæmia. In short order surgical literature was enriched with reports of new cases wherein splenectomy was followed by tolerably favorable results. Huber, Mosse, Hirschfeld, Klemperer, DeCastello and Hassing reported favorably; and at the Forty-third German Congress of Surgery (1914) Mühsam exhibited 15 cases of pernicious anæmia with performed splenectomies and gave evidence of the good results attending such procedure. Shortly after this demonstration, however, quite unsatisfactory reports accumulated, whether through an inherent inefficacy on the part of splenectomy to aid in correcting the pathology of pernicious anæmia, or from the innumerable complications like œdema, cardiac and pulmonary disturbances, hemorrhages, to which sufferers of pernicious anæmia are peculiarly prone.

Our present knowledge would direct a splenectomy in those cases only where a distinct splenomegaly evidenced by a marked tumefaction of that organ exists, and even in these cases, only illusive hopes as to recovery should be entertained.

Tuberculosis and Incident Splenomegaly.—In tubercular processes miliary or nodular involvement of the spleen occurs. More often this is secondary to an initial tubercular lesion elsewhere situated; but rarely, primary affection of the spleen has been recorded. In 1900 Bessel-Hagen reported three cases of clinical cure following an extirpation of primary tuberculosis of the spleen; and in 1901, Carle removed an enlarged spleen,

thinking the case to be one of Banti's disease, but found it a primary tuberculosis of the spleen. The patient, a female, recovered completely and shortly afterward gave birth to two children.

Laspeyres (1904) reports 2 cases analogous to that of Carle. Bayer in the same year reports 9 cases with 7 recoveries; Johnston (1908) reports 6 cases with 3 recoveries; Francke records 10 splenectomies for primary tuberculosis of the spleen with 7 complete recoveries; Fischer (1909), 12 cases with 8 recoveries; recently Michelsson reports 25 per cent. mortality in his series of cases.

Syphilitic Splenomegaly.—It has been comparatively well established that splenic tumefaction with diffuse interstitial sclerosis and endo- and epi-vascular lesions (Paris and Salmon) may be the only manifestation of hereditary syphilis (Fournier), and as the result of which there may be derived a symptomatology clinically and anatomically similar to that of Banti's disease (Michelli, Marchand, Hoke and Chiari); only two such cases wherein a splenectomy was performed have been recorded (Mansuso, 1888, Zuaccaro, 1901). Both were followed by favorable issue. Giffin reports that removal of the spleen in non-gummatous splenomegaly associated with syphilis has been attended with excellent results in two cases.

Doubtless such intervention should be adopted only after the most drastic antisyphilitic therapy fails.

Malarial Spleen.—As was indicated, splenic hypertrophy and hyperplasia owing to malaria was the first incentive for surgical intervention (Zaccarello). This precedent has remained.

In the spleen in preference to any other organ, the red blood-cells harboring the plasmodium are destroyed and the parasites liberated. These accumulate in the splenic lacunæ and give out their products of metabolism. The liver, independent of a primary malarial infectious localization, and intimately related in its blood supply with the spleen, suffers from the action of the malarial parasites collected in the spleen, (1) from the parasites that are able to issue alive from the splenic nest; (2) from the products of metabolism elaborated by the parasites in the splenic lacunæ; and (3) from the toxic action of the destroyed protein of the hæmolyzed red blood-cells gathered in the spleen.

The pathological effects of these circumstances upon the liver are obvious and formed the basis of the reason for splenectomy in malaria. Agreement between pathological reasoning and surgical practice, however, has not always been too perfect. Some operators have been highly successful, others highly disappointed with the outcome of the measure. The following statistics are worth consideration in this regard:

	Cases	Deaths	Mortality Per cent.
Bessel-Hagen	15	1	6.6
Vanverts	29	1	3.45
Papaionnon	12	1	8.33
Leonte	10	0	0

Splenomegaly Owing to Other Parasitic Infection.—It is difficult to collect any authoritative reports relative to splenectomy in splenomegaly incident to kala-azar. Ill success has been reported; but whether other than splenic involvement existed does not appear.

In summary splenectomy would appear to be indicated in:

1. Banti's disease, first stages particularly.
2. Griesinger disease.
3. Minkowski-Chauffard and Hayem-Widal jaundice.
4. Primary splenic tuberculosis.
5. Hereditary splenic syphilis (after medication fails).
6. Chronic malaria attended with splenomegaly.

Splenectomy is of questionable benefit in:

7. Splenic infantile anæmia.
8. Pernicious splenomegalic anæmia.
9. Gaucher's disease.

It is contra-indicated in:

10. Splenomegaly incident to leukæmia and pseudoleukæmia.
11. Splenomegaly of kala-azar.

INFLAMMATORY TUMORS OF THE ABDOMEN

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On December 10, 1914, there was brought to me a woman, K. G., aged nineteen, complaining of pain and a lump in the abdomen. Her general health prior to her present illness had been uniformly good. Her past history was unimportant aside from the fact that she had given birth to a normal child six months previously, and had passed an uneventful puerperium. Six weeks before she was seen she had right-sided abdominal pain of a colicky nature which subsided in two or three days; at this time a diagnosis of appendicitis was made by the attending physician. Two weeks later dull pain developed in the left lower abdomen, when for the first time the patient discovered a lump. These two complaints—dull pain and a lump—have been the two outstanding features. The patient thinks the lump has increased a little since it was first noticed. There has been no fever so far as can be ascertained. No symptoms referable to the bladder or intestines could be elicited. There has been a loss of about ten pounds in weight.

Physical examination revealed a rather under-nourished and anæmic woman. The general examination was negative except for the findings in the left side of the abdomen. On inspection, one saw in the left iliac fossa, a fulness, which on palpation proved to be a mass. This extended upward three cm. above the umbilical level and downward to within three cm. of Poupart's ligament; it reached the midline to the right and slightly into the flank posteriorly. The mass was only slightly tender to the touch, its consistency quite hard, and its surface somewhat irregular. No fluctuation was elicited. It was almost immovable and gave one the impression of being in the abdominal wall or at least densely adherent to it. Dulness on percussion was present over the involved area. The mass was not palpable through the pelvis and the pelvic organs seemed uninvolved.

The temperature and pulse during two days of observation were normal. The urine was normal. Wassermann reaction was negative.

In the face of these findings we were at a loss to explain the underlying condition and subsequent events proved that a correct pre-operative diagnosis would have been very difficult. Abscess arising from a left-sided appendix or diverticulum, adherent ovarian cyst, sarcoma of the ovary, tumor of the abdominal wall, tumor of the sigmoid or retroperitoneal structures, and localized tuberculosis were some of the possibilities that were considered.

Exploratory incision was made through the left rectus muscle over the most prominent part of the mass. When the sheath of the muscle was opened, the muscle fibres were found to be infiltrated and to a great extent replaced by a firm, homogeneous tissue. No peritoneal membrane could be demonstrated. Just beneath the muscle and densely ad-

herent to it was encountered a very hard, non-fluctuant mass about the size of a small grape-fruit. This was looked upon as a new growth, and an attempt was made to remove it along with the overlying muscle. The peritoneal cavity was entered above and below the tumor. A good exposure revealed the omentum and several loops of small intestine intimately adherent to it. The sigmoid passed directly into the tumor mass. The adhesions were so dense and so extensive that attempt at removal was abandoned. After the peritoneum was closed, a blunt clamp was plunged deeply into the mass; no pus or fluid escaped. Pieces of tissue from the mass and the infiltrated muscle were removed for examination. The wound was then drained and closed.

Pathological Report (Dr. B. F. Stout).—"The tissue submitted consists of two pieces; one, what is apparently tumor tissue, and the other a piece of muscle. The former measures 3 by 2 by 1 cm. It has the gross appearance of sarcoma. It is quite firm and non-resilient to the touch; its substance offers considerable resistance to the knife. The cut surface is homogeneous in appearance and pinkish white in color. When the surface is scraped a small amount of grayish material comes away.

"In the small piece of muscle one can see bands of tissue like that described above surrounding the muscle bundles; and in places the muscle itself has been supplanted by the firmer tissue.

"Under the microscope the picture is as follows: A major part of the tissue consists of large oblong cells with a distinct oval nucleus and an ill-defined cytoplasm. These cells vary somewhat in size but for the most part are quite uniform. When seen in cross section, the cell-outline is somewhat flattened and the nucleus round. No definite stroma—or at least no stroma that can be differentiated from the spindle cells described—can be demonstrated. A few small lymphocytes are seen scattered throughout the tissue. No leucocytes are present. The blood-vessels are thin-walled and are surrounded by a small amount of connective tissue.

"This tissue is thought most probably to be inflammatory, although malignancy is a strong second possibility. The cells give one the impression of being fibroblasts rather than sarcoma of the spindle-cell type."

Postoperative Course.—Despite this report, it was difficult to convince those of us who saw this case at operation that we were not dealing with malignancy. The element of time was the deciding factor.

On the 2d day after operation the temperature rose to 101 degrees and on the 3d day pus began to drain from the wound in considerable quantities. No sulphur granules were found in the pus. After a few days, the fever disappeared, but free drainage of pus continued for about two months. At the end of a month the tumor had disappeared but the induration of the abdominal wall had extended so that it involved practically the entire abdomen. The patient's condition at this time was considerably improved. The induration gradually subsided and had disappeared in three and one-half months. At this time the patient was able to be up and to do her house-work; she was free from pain and felt well; her bowels were moving regularly. The wound had healed except for an area the size of a ten-cent piece; just above and to the right of the incision a similar-sized granulating, papillomatous area was present.

Both these areas had healed two or three weeks later. A letter from her physician two years after the operation describes her condition in these words: "I had K. B. to come to my office to-day. She tells me she is as well as she ever was, and her looks verify that statement. She looks well, and has gained twelve pounds. Menstruation has re-established itself. There is no discharge from the wound and no soreness or hardness of the abdominal walls."

The outcome of this case leads me to believe it to be an example of what is called inflammatory tumor of the abdomen. This condition, of course, is not a new one; but it is one that has been given a place as a clinical entity by virtue of a more intensive study of tumors, true tumors having thus been separated from pseudo-tumors. The Catalogue of the Surgeon-General's Library, First Series (1893), contains no reference to inflammatory tumors of the abdomen; the Second Series (1913) has less than half a dozen references to the condition. One particular type, namely, inflammatory tumors of the omentum, has received attention for a longer time; Pean, as early as 1880, recognized and assembled a triad of symptoms which he considered diagnostic. A recent paper by Peterhauvahr summarizes our knowledge of this type. This author reports forty-four (44) cases from the literature and of these thirty-six (36) followed previous operations, mostly herniotomies. It is noteworthy that Peterhauvahr makes no reference to the early work of Bull and Coley in this country. Hessert has since added two other cases following hernia operations. About ninety per cent. (90%) of these cases were due to the use of non-absorbable suture material coupled with a probable low-grade infection.

The past few years have produced several contributions to the subject under discussion. Hamann in 1910 considered these inflammatory tumors in their simulation of neoplasms and here one finds the best summary in English of the subject as a whole.

The most recent and most comprehensive communication is a paper by an Italian, Gino Baggio. This author reports two personal cases and contributes a most exhaustive study of the whole subject. In a reasonably short space it will be impossible to do more than epitomize this work.

Baggio classifies the collected cases into two groups, intraperitoneal and parietal. The latter group is probably primarily intraperitoneal, the process having its origin in or about some hollow viscus and involving by adhesion and extension the adjacent abdominal wall. The intraperitoneal group is divided into sub-groups which indicate the region involved, *viz.*, stomach, cæcum, any part of the colon, sigmoid, omentum, liver and bladder. An inflammatory process may begin in any of these locations and gradually assume the size and characteristics of a true tumor.

The pseudo-tumors which sometimes form about ulcers of the stomach and duodenum are probably the best known of the abdominal inflammatory tumors. It is not unlikely that many of the reported cases of gastric resection or gastro-enterostomy for cancer which recovered were only inflam-

matory in nature. It is with this thought in mind, no doubt, that Mayo Robson advises gastro-enterostomy in all tumors of the stomach which cannot be removed.

A particularly interesting group of inflammatory tumors are those which form about a foreign body. They may occur about nonabsorbable suture material either in the abdominal wall or in the wall of some of the hollow viscera. A foreign body in the lumen of the intestine or in a diverticulum may be provocative of sufficient inflammatory response to simulate a neoplasm, and again such foreign bodies as pins, needles, pieces of wood or glass, etc., may migrate into the wall of the bowel, or the wall of the abdomen, with a similar result. Wagner has described a very extensive case in which the cause was found to be part of a metallic instrument left in the abdomen at a previous operation. Doubtless in all these cases the added factor of infections plays a considerable part in the proliferation of connective tissue.

It is interesting to speculate as to the relation of inflammatory tumors to the infectious granulomas and to desmoids. It is easy to understand how syphilis, tuberculosis, or actinomycosis may be responsible for a tumor which is truly inflammatory, but the process would be quite different from the one under discussion. In the one case the causative factor is specific, whereas in the other it may be variable. The use of the Wassermann or other specific tests, therefore, should be resorted to in all cases.

Inflammatory tumors of the parietal type may clinically and microscopically closely resemble desmoids. The term desmoids is one applied to dense fibroid tumors in the abdominal wall which in point of malignancy stand between sarcomas and fibromas. They occur usually in women and are very prone to occur during pregnancy and after parturition. Their etiology is obscure; traumatism no doubt plays a part. Balfour is of the opinion that a predisposition on the part of the individual toward overgrowth of connecting tissue must be present as well. Suffice it to say that without the microscope, or even with it, confusion may arise.

Only a word as to diagnosis will be added, because a definite diagnosis is usually impossible even when the tumor is exposed. A careful microscopical examination is the only certain method of diagnosis and if possible this should be done during the operation before any attempt at radical removal is made.

Baggio epitomizes the treatment in these words: *noli me tangere.* That this conservative plan of treatment is justified is proven by the fact that out of 47 cases collected by him exploratory operation sufficed to bring about a cure in 37. On the other hand, out of 10 cases where radical removal was resorted to, 4 resulted fatally. It should be remarked that in many of the cases collected by Baggio, conservative treatment was used because of necessity rather than by choice. The tumor was considered malignant and its true nature was known only after microscopic examination of an excised piece or after the tumor had disappeared.

With the tumor exposed it is a great temptation to attempt its removal,

but it is the better part of discretion, particularly where important organs are involved, for one to be content with simple drainage and excision of a section for diagnosis. Should it prove malignant, thorough excision may be practised later in suitable cases.

In conclusion, the important thing to remember about this subject is that the existence of inflammatory tumors is a clinical fact. Every tumor-like mass in the abdomen is not malignant and may not be a tumor at all in the true sense of the word. The naked-eye appearance may be misleading and only the microscope can reveal the exact condition. The proper management of inflammatory tumors of the abdomen requires a nicety of surgical judgment which should tend in all cases toward conservatism.

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ON OSSEOUS CYSTS AND SO-CALLED GIANT-CELL SARCOMA

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True osseous cysts are of a non-malignant nature, and are generally solitary in the large cylindrical bones, more especially in younger individuals. Their etiology has not been determined with any certainty.

Speaking generally, osseous cysts originate from a variety of causes. Thus they may be the result of a past inflammation—infectious osteomylitis—or of parasitic origin—echinococci and cysticerci; of softening of tumors, more especially chondromas and sarcomas; also of certain osseous diseases with rarification, as senile osteoporosis, common osteomalacia, perhaps also Barlow's sickness, and most often of ostitis fibrosa.

If the two former groups are eliminated, the question, as a rule, will be whether the cyst or defect is the result of a tumor or caused by one of the rarefying diseases just mentioned.

After Virchow, the medical world in general accepted the idea of tumors as the main origin of most of the cysts in question, which were considered malignant and treated accordingly. In the course of time a change of ideas took place, and it was pointed out that osseous cysts originating from tumors were far rarer than generally assumed, and that the tissue often was of a non-malignant character, even when its structure resembled that of sarcoma strongly enough to make a mistake possible. In other words, the disease in the bones would be due, in these cases, not to malignant tumors, but to disease of a different nature.

A closer study of rarefying osseous diseases revealed cysts, the walls of which often contain a giant-cell tissue, rich in cells, of sarcoma-like structure, even when the disease could not possibly be regarded as a malignant growth.

The study of one disease especially—ostitis fibrosa—shed a fuller light on these problems. Ostitis fibrosa seems to occur rather often in certain countries, *e.g.*, England (cfr. Paget's disease—ostitis deformans) but is rarely seen in Norway in more advanced form. Milder forms, however, with one or few foci are found quite frequently.

As this disease develops, a tissue of a fibrillar character appears in the bones, the marrow is changed into connective tissue, bone substance is resorbed, and cysts, often large, are formed. Side by side with this retrogressive change, a progressive process takes place with new growth of bone or osteoid tissue, and quite often a proliferation of cells so vivid that the tissue produced may easily be mistaken for a giant-cell sarcoma.

In the following I shall try to describe in full this tissue which is of great interest from a clinical as well as an anatomical point of view.

From the examination of solitary osseous cysts it has been learned that the nature of the process is frequently neither simple nor easily explained.

The cyst, or perhaps it would be more correct to say the defective part

of the bone, is often filled with a tumor-like tissue which microscopically would easily be mistaken for giant-cell sarcoma. It must, however, be kept in mind that a similar tissue is found not infrequently in quite small quantities scattered in the connective tissue surrounding smooth-walled cysts, although it cannot here be considered as a typical tumor tissue. Therefore great care must be taken before the diagnosis of sarcoma is made.

Ostitis fibrosa—local or general—closely resembles osteomalacia. In the latter we have more or less tissue, rich in cells, and resembling in structure giant-cell sarcoma, even macroscopically, but the tissue cannot be considered as of typical tumor growth here either.

When a bone cavity is found filled with tumor-like tissue instead of a mucous or serous fluid, the reason may be because the progressive process is strong enough to prevent the formation of cysts. A preparation to be discussed later shows conclusively, according to my opinion, that these two processes may exist side by side. This preparation shows in the tumor-like tissue a number of cysts surrounded by mucous tissue with few cells, partly by tissue rich in cells which forms the main part of the contents of the cavity (Case 4).

Clinical experience shows that bone cavities in so-called giant-cell sarcoma can be cured by conservative treatment, which would not be the case if a true sarcoma were in question.

In this case, as so often in medical science, one method of examination or one isolated symptom is not sufficient for a true diagnosis. Exploratory excisions and microscopic examination frequently lead to the goal, but in ostitis fibrosa experience has taught us that even the disclosures of the microscope may be misinterpreted. If besides the tumor-like tissue a piece of the surrounding bone wall is available for examination it will be a very valuable help to the investigator. As mentioned, in the case of ostitis fibrosa, the marrow is changed into fibrous tissue, accompanied partly by resorption of bone and partly by the formation of new bone.

If, therefore, these changes are found side by side with tumor-like tissue, the diagnosis must be ostitis fibrosa with a giant-cell tumor.

Many authors use the name ostitis fibrosa with giant-cell sarcoma, but the name is not well chosen, as experience shows this tumor-like tissue is benign, whereas osseous sarcoma is not.

Giant-cell tumor therefore must be considered a more correct and more non-committal name for this sort of tissue. The word has been proposed by other authors, but seems to be used but rarely.

Even if only a small piece of the tumor-like tissue is available for examination, the course of the disease with its clinical picture seen in connection with the microscopical appearances precludes the diagnosis of sarcoma, which would otherwise seem obvious at first sight.

The tumor-like tissue is of a peculiar, dry consistency, somewhat resembling the dry substances of thrombi in the heart and veins; it crumbles easily and thus differs from ordinary sarcoma tissue which is much more elastic.

[1] Norsk Mag. f. Laegev., 1915.

The color is generally a dark brownish-red,—in two of my cases large parts of the tissue were yellow.

The microscopic picture, described in detail in each case reported, also shows a peculiar structure which is easily recognized, although it is not possible to give any decisive distinguishing features between sarcoma and giant-cell tumor. If the resorption of the osseous substances can be shown to take place in connective tissue with few cells, if, in other words, fibrous marrow is found, then that fact would indicate that the bone-destroying process is not of a malignant character.

The most striking feature of the disease is the enormous giant-cells with 50 to 100 nuclei in one section. The picture on the whole shows a varied structure with regions rich in cells and bands of connective tissue, often showing hyaline degeneration; between them every variety merging into tumor-like tissue, also bone substance in the process of formation, resorption, and once in a while islands of cartilage. The cells are mainly round or oval, their protoplasm most often clear and well defined in outline; frequently no intercellular substance can be traced.

On the other hand, a giant-cell sarcoma under the microscope shows a more homogeneous tissue, with no such extensive spots where cells are few. The shape of the cells is more like a spindle, the intercellular substance more abundant, and besides the giant-cells we find all intervening stages down to cells with 2 to 4 nuclei—a thing rarely seen in the case of giant-cell tumor.

Many authors are of the opinion that the giant-cells are combinations of osteoclasts; they frequently absorb pigment, and if this can be proved to any extent we have gained a point towards deciding that the tumor-like tissue is not sarcoma, as the latter never shows pigment to any extent in the giant-cells.

We have also been told that if giant-cells are seen in clusters this fact would be an indication that the tumor tissue is part of ostitis fibrosa, whereas in the case of sarcoma the giant-cells would be more evenly distributed throughout the tissue. This statement does not conform with the fact of the 9 cases I have studied. They show no pronounced clustering of the giant-cells; in nearly all the preparations the latter are evenly distributed over all parts of the tissue.

The accumulation of pigment in the giant-cells does not seem to be a reliable test. None of the cases show any special preference on the part of the pigment for the giant-cells. If present at all, the pigment is mainly found in the stroma or in the cells with a single nucleus.

Bloodgood insists on the benign character of certain tissue, however much it may resemble giant-cell sarcoma, but in spite of this he still uses the name "giant-cell sarcoma."

Utterström also pleads that the tissue frequently seen in osseous cysts, though like giant-cell sarcoma, is not of a tumor nature, but must be considered as a result of chronic inflammation.

I came to take up this subject by reason of some pieces from a growth in the tibia sent to the laboratory of Professor Harbitz with an inquiry

whether the disease was a sarcoma (Case I). Other cases were placed at my disposal later.

Case I.—Man, aged twenty years, patient of Dr. Barth, Arendal, had always been in good health, but fourteen months before presenting himself something struck him on the tibia just under the knee-joint, and since then he had a pain in his leg off and on. When seen the upper part of the tibia was swollen, mainly inward.

October 3, 1915, a few small pieces of tissue in tibia were excised and sent for examination.

The tissue was tumor-like, rich in cells, the cells polymorphous, from small round or spindle-shaped cells to large giant-cells with numerous nuclei placed centrally. A series of cells were large, round or oval, with deeply stained nuclei and well-defined protoplasm. Intercellular substance sparce, homogeneous (Figs. 1, 2 and 3). Diagnosis: Giant-cell sarcoma.

At operation, October 11, 1915, a large cavity was found in the bone, filled with brownish-red tumor-like tissue which was carefully scraped out. The outer wall of the bone was as thin as paper and partly affected. In the upper part of the cavity was a cauliflower-like mass which was taken out with the finger; the tissue next to the wall of the bone was a fibrous leathery membrane.

The matter scraped out from the tibia, as much as a small apple in all, was crumbly, homogeneous, on cut surface, brownish-red, infiltrated with hemorrhages. Under the microscope was seen the same polymorphous cell structure as before, moreover considerable fibrillar tissue next to the bony wall is sclerotic with few cells, in which are scattered larger or smaller cellular areas of the same structure as described.

The cavity of the wound became infected, and eight or ten days after the operation an abundant growth of tumor-like tissue appeared, and amputatio femoris was made, the patient, six months after the operation, being quite well, without any signs of recidivation or metastasis.

The amputated part, about 5 cm. below the articular surface of the tibia, showed a wound, 5 cm. by 2.5, which passed into a cavity in the tibia, the diameter of which was 1–2 cm. and length from top to bottom 9 cm. The lateral walls of the cavity were smooth in the upper and lower parts, and consisted of a soft tissue, 1–2 mm. thick, which covered all the underlying bone. At the top of the medial side, and also in the middle, a soft mass of tumor-like tissue bulged.

When the bone was sawed (Fig. 5), the roof of the cavity proved to be a soft tissue which had partly destroyed the spongiosa to the cartilage; 5 cm. below the articular surface the back wall was destroyed to an extent of 3 cm. by 1. In front, about 1 cm. below the medial articular surface the cortical layer was also destroyed and penetrated by a somewhat firmer tumor-like substance of a greyish-white color, the size of a pigeon's egg outside the bone, and well defined from the muscles.

The X-ray photograph (Fig. 6) shows destruction of bone and new bone substance in the periosteum which contains several well defined small cysts in the region towards the head of the fibula.

A section from the spongiosa with the cartilage showed the cartilage to be normal, whereas the underlying spongiosa was more or less destroyed. The space between the trabeculæ was filled partly with a finely fibrillar marrow of connective tissue with few cells, partly with a tumor-like tissue rich in cells. Alongside the trabeculæ numerous osteoclasts with one or more nuclei (Fig. 7).

A section from the compact bone, just below the affected place, showed the bone in process of destruction, surrounded by fibrous marrow with few cells and with osteoclasts. The spaces where all bone substance had been destroyed were filled partly by the same sort of many-celled tissue as was found in the cavity of the bone, partly with a fibrous tissue with few cells. Several places showed clearly how the bone loses its calcareous matter which is diffused into the connective tissue.

In a section from the marrow at the transitory stage towards the tumor tissue, the bone marrow was changed into fibrous tissue with few cells, with here and there small portions of many-celled tissue; downwards it had changed into normal fat marrow.

A section from the tumor, the size of a pigeon's egg, outside the periosteum showed the growth to be enclosed in a capsule of connective tissue; it consisted of the same giant-cell tissue which has been described.

Summary.—Clinically, this case would most likely be regarded as a sarcoma, and as such it was considered by the surgeon who had then no option but to amputate. A favorable result could hardly have been obtained by a conservative treatment, in this case a resection. The bone was destroyed too much; moreover, the articular surface of the tibia would have had to be taken as well. When the cavity in the bone was scraped, some of the tissue was left. The mechanical irritation at the operation with the secondary infection in the wound may have caused the prolific growth of the remaining tissue—a recidivation which all the same is no proof that the tissue was of a malignant nature. From the description of the preparation we learn that the tumor-like tissue had penetrated through the periosteum and grown outside the same but without infiltrating the muscles. The tumor was well enveloped in a capsule of connective tissue, indications that the tissue was not malignant.

The Röntgen photograph does not show the picture commonly found in ostitis fibrosa. The destruction of the bone is remarkably diffuse with a growth of tumor-like tissue outside the periosteum, a fact that suggests sarcoma, but as several authors have pointed out, the Röntgen photograph gives but little help in doubtful cases. In this case it would indicate a sarcoma, while a series of other things, more especially the microscopic examination, indicate an ostitis fibrosa. The bone-marrow is to a great extent changed into fibrous tissue and the destruction of the bone proceeds mainly from this tissue, which would not be the case in sarcoma in which the tumor tissue destroys and perforates the bone. The many-celled sarcoma-like tissue does not grow in the connective tissue with few cells till after the destruction of the bone has taken place. It is true that in a few places towards the articular surface we see that the tissue lying close under the bone trabeculæ destroys them, but this may quite possibly be due to the remarkably rapid growth of the tissue after the operation.

The main feature of the tumor-like tissue is the polymorphous cell picture, showing large round cells with a well-defined protoplasm; the numerous giant-cells, and, alternating with this tissue, the fibrous portions with few cells, points which distinguish it from an ordinary sarcoma which generally shows a more homogeneous growth, less polymorphous cell formations and has not any fibrous, poorly cellular portions, which show all stages up to the rich cellular tissue.

Anatomically this case must be considered as an ostitis fibrosa with giant-cell tumor.

There is in favor of this diagnosis also the fact that the patient after six

months showed no sign of recidivation or metastasis. Sarcoma of the bones is well known for its malignity, and here we see no recidivation in spite of the fact that the skin was not more than one cm. distant from the tumor-like tissue growing outside the periosteum.

A sarcoma of that size with such proliferation of cells would hardly have given so satisfactory a result.

Similar cases have been described by several authors. Bloodgood has written exhaustively on this subject, on the basis of 89 cases of osseous cysts, partly seen by himself, partly collected from the literature, and in 53 of these there were growths with a more or less pronounced resemblance in structure to that of giant-cell sarcoma. Bloodgood calls them sarcoma, but states that they are benign and that conservative treatment is indicated. His cases were treated partly with curettement, partly with resection or amputation; they all had one feature in common, viz., that in no case did metastasis occur. In a few cases the periosteum was perforated, and there was a tumor-like growth in the soft portions; the patients were cured by resection.

Other authors describe the occurrence of metastases, but judging from their descriptions their cases seem to have been multiple foci of the same disease; metastases in glands or other organs have not been found.

Case II.—A fisherman, forty-six years old. Service of Professor Bull. Trauma in the knee region ten and three years ago.

October 17, 1913: Some atrophy of right leg; upper part of tibia somewhat thick; normal mobility in knee-joint. The Röntgen photograph showed a considerable destruction in the upper end of the tibia which was swollen and the corticalis changed into a thin shell, indicating cavities varying in size up to that of a hen's egg. Between them, thin dividing walls will be seen. The outline not very sharply defined (Fig. 8).

At operation the cortical bone layer in the swollen part was 1–2 mm. thick; by chisel a large cavity was opened from which about 100 grams of yellowish tissue mixed with blood-coagula were removed with a sharp spoon. A secondary cavity down towards the medullary canal was filled with a more firm tissue, near the outside fibrous, the surface of greyish and greyish-yellow color, while the inner portion was a brittle, necrotic material, the color of ochre.

February 6, 1914: The cavity granulating; holds 90 c.c. of water.

April 15: Little secretion: cavity holds 50 c.c. of water.

April 28: Patient leaves the hospital; cavity holds 45 c.c.

Nine months later the cavity holds 35 c.c., slight discharge, without smell. Two and a half years after the operation the cavity holds 10 c.c. of water; no sign of recidivation.

Microscopic Examination.—The firm tissue in the lower part of the cavity is fibrous with comparatively few cells having long narrow nuclei. The layers of cells are divided from each other by an abundance of striped intercellular substance partly showing hyaline degeneration (osteoid tissue?), and which in some places seem to form masses of a more pronounced color—a commencing calcification.

Areas of cellular tissue are seen, with spindle-shaped or round cells of a somewhat larger size, also groups of fat-containing cells. On the inner side towards the yellow substance the tissue becomes more rich in cells, the latter are more polymorphous, an increasing number contain fat. The cells are round, oval or spindle-shaped, partly with and partly without distinct intercellular substance. In many of the round cells the outline of the protoplasm is well defined.

Furthermore there is a plainly osteoid substance with small cells in heaps and an abundant intercellular substance, also newly formed bone-substance, resembling spongy bone, with intermediate stages of osteoid tissue with calciferous deposits, the osteoid portions appearing as part of the tumor, and are not surrounded by osteoclasts. Bone trabeculæ in process of resorption are seen covered with osteoclasts; between the trabeculæ is connective tissue with rather few cells. Numerous giant-cells are scattered throughout, irregular in shape and outline, with numerous nuclei non-pigmented; fat-containing cells for a great part of the tissue (note the yellow color); they have small round nuclei in the centre of a protoplasm with a **fine reticulum and vacuoles. Diagnosis, sarcoma of tibia with polymorphous cells.**

Clinically the disease was considered as benign and the patient was treated conservatively by scraping the cavity; two and a half years later the cavity had nearly filled itself, with no sign of recidivation or metastasis. We may therefore conclude that there was not a malignant tumor. The cellular tumor-like tissue with new bone substance is due to a productive process in the connective tissue, going on side by side with the bone destruction. A closer examination of the microscopic preparations also indicates that the diagnosis of sarcoma was not correct because sarcoma does not show so heterogeneous a character with large poorly cellular fibrous portions with intermediate stages up to a cellular tissue; nor does sarcoma show osteoid tissue and new bone as in the present case. In the parts showing destruction of bone, the trabeculæ are surrounded by fibrillar tissue; that is, it is not the tumor tissue that destroys the bone, as would have been the case in sarcoma. The giant-cells are not so large as they frequently are in ostitis fibrosa, nor does the tumor-like tissue contain so many round cells with a clearly defined protoplasm as is often the case.

Hence, the case may be considered as a local ostitis fibrosa with giant-cell tumor in which the productive process has filled up the defect in the bone as quickly as bone was absorbed. Besides the usual cellular tissue, a quantity of yellow tissue was found, with fatty cells that must be considered as young fat tissue. The fat only formed small drops in a fine network in the protoplasm and the nucleus was central. This tissue appeared to originate from the same elements as the tumor-like tissue and formed an integral part of the tumor.

I have found nothing quite similar in any of the cases I have studied. In Case V a yellow and reddish-brown tissue was found in the cavity, but the yellow tissue does not appear to have been specially examined by microscope, so that it is impossible to decide whether it was fatty.

This finding has, however, hardly any differential value and is probably a rare occurrence in ostitis fibrosa and is seen also in sarcoma.

Case III.—Man, aged twenty-four years, service of Professor Bull. Always well, no known trauma. A little before Christmas, 1905, pain in the leg, and shin somewhat swollen at Christmas-time, otherwise well. The swelling has grown constantly but has not hampered him in any way, so that he was even capable of military service that summer.

August 2, 1906: Between the upper and middle third of right tibia is a swelling 8–10 cm. in length, hard as bone, of even surface, skin normal.

August 3: Incision and opening by chisel of a cavity in the tibia about the size of a goose egg, filled with a dark brownish-red fluid. The inside was partly covered by a thin gelatinous membrane. The whole of the thin bone lamella which formed the medial wall of the cyst was loosened from the soft parts and taken away. A smaller cavity was found also, the size of an almond, filled with a firm tissue, and connected with the medullary cavity.

August 24: The wound healed. Ten years after the operation the patient states that he is in perfect health and has had no signs of any bone disease since the operation.

The microscopic preparations of the cyst wall show a varied tissue, partly cellular and tumor-like, partly mucous with few cells; the latter appears to have formed the inside of the membrane. The cellular tissue consists of round cells with a distinct, well defined protoplasm of spindle-shaped cells with an abundance of finely fibrous intercellular substance, and of numerous giant-cells with central nuclei. In several places small masses of newly-formed bone are seen. In one place is seen bone resorption surrounded by fibrillar tissue. The firm tissue in the small cavity was not examined.

Generally fibrous ostitis attacks the spongy portion of the bone; in this case it must have originated in a canal in the shaft of the tibia. A part of the bone was destroyed with the formation of a cavity succeeded by exudation which caused the periosteum to swell and new bone to form so that the peripheral part of the cyst was covered by a bony shell as thin as paper. At the same time there was proliferation of cells and formation of a tissue resembling giant-cell sarcoma in the thin membrane surrounding the cyst and in a small area outside, the latter unfortunately was not examined microscopically.

The cellular tissue resembles very much giant-cell sarcoma, the diagnosis given immediately after the operation. Clinically, however, the disease was regarded as benign and conservative treatment cured the patient. No recidivation after ten years proves the process was not malignant.

In the museum of this institute are two preparations, which show the typical characteristics of ostitis fibrosa, from Dr. Jervell, who gives the facts now known as to one of the patients, the fate of the other is unknown.

Case IV.—Left leg amputated 24 cm. above the lower end of the femur; knee joint normal; palpation of the outer cartilage of the tibia shows that it yields to pressure; the upper end of the tibia is much swollen and after being sawn through shows a growth, 7 by 8½ cm., of a round or faintly oval shape; the outline is well defined, bounded above by cartilage, laterally and in front by periosteum, in which some spicula of bone are scattered, below by a saucer-shaped depression above the point where the marrow cavity begins (Fig. 9).

The substance of the growth consists of a soft, rather brittle tissue, containing, more especially in the middle part, a great many cavities, varying in size from quite small up to that of an ordinary dried bean, and filled with coagulated blood or a colorless substance resembling colloid. The surface thus looks like a network with beams and islands of tumor-like tissue, embracing cavities (Fig. 10) with colorless or dark, partly blackish-brown contents.

Microscopically, the cysts are surrounded partly by a myxomatous tissue, partly by a cellular tumor-like tissue, the cells of which are polymorphous, some

small and round, some spindle-shaped, some large, round or oval; of the latter many have a well-defined protoplasm. Scattered in all parts of this tissue are numerous large giant cells with more than 50 nuclei in one section. The nuclei are massed together in the centre of the cell (Fig. 11). In most parts of the tissue there is a finely fibrillar intercellular substance. Besides, fibrous parts are seen, in one place with a cluster of giant-cells (Fig. 12). A rudimentary formation of new bone occurs at several places in the cellular tissue.

Sections from the borderline between the tumor-like tissue and the bone marrow show a sudden change from the normal fatty marrow to the tissue described.

Destruction of bone takes place in the fibrillar connective tissue in the canals and the marrow cavities, the trabeculæ being studded with osteoclasts with one or several nuclei. The bone changes into connective tissue and a profuse proliferation of cartilage is seen at several places in the latter. The cellular tumor-like tissue is found within these parts.

This is the case which I mentioned as showing the formation of cysts side by side with the growth of tumor-like tissue. In this case, as in the others, it is not the cellular tissue that destroys the bone, but the more fibrous, and in the connective tissue thus formed is a growth of cellular tissue in larger or small areas. As in the other cases of ostitis fibrosa with tumor, we find a heterogeneous tissue, fibrous portions alternating with cellular tissue, and myxomatoid tissue is formed in profusion. In one section, cartilage is found and also new bone formation in many parts of the cellular tissue. Giant-cells occur in great numbers, and their nuclei are exceedingly numerous; the other cells are polymorphous, round, oval or spindle-shaped, altogether a picture that decidedly speaks against sarcoma. We see the whole of the tumor-like tissue honeycombed with cysts formed by softening in the myxomatous tissue (Figs. 11 and 12). Macroscopically, the periosteum is unbroken in spite of considerable swelling and formation of cellular tissue. No metastasis occurred. The conclusion to be drawn from all these facts is that the case cannot be considered to be a sarcoma, and the diagnosis must be ostitis fibrosa with giant-cell tumor.

Case V.—Woman, twenty-nine years old. During recent years pain across right instep; in April, 1902, a tumor was found corresponding to os cuneiforme I. Operation in September, 1902, showed this bone to be changed into a rather soft mass, with a cavity the size of a hazelnut, and filled with a serum-like fluid. The process was limited to this bone, which was taken out; thirteen years later, no recidivation or metastasis.

The microscopic preparations show a cellular osteoid substance with spindle-shaped and star-shaped cells and homogeneous intercellular material. In this tissue are areas of tumor-like cellular tissue consisting of polymorphous cells of a character resembling connective tissue. Many of the cells are large, round or oval with a well defined protoplasm. Numerous giant-cells with clusters of nuclei placed centrally occur throughout the tissue; the protoplasm in some of them contain vacuoli. The intercellular substance is partly homogeneous, partly finely fibrillar. The borderline of the osteoid tissue is clear and sharp, and in several places giant-cells are ranged in rows alongside.

Just under the cartilage is osteoid tissue with bone spicula, set with osteoclasts and surrounded by connective tissue, not particularly rich in cells—a fibrous

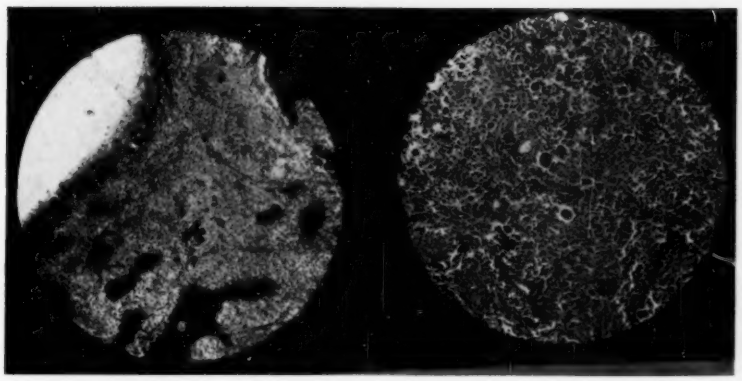
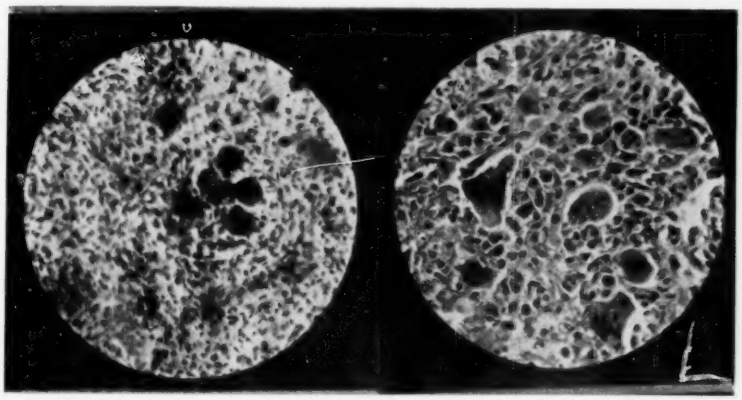


FIG. 1.—Case I. Above to the right is seen the wall of a cyst bordered by a tumor-like tissue containing giant-cells. The rest of the tissue is also cellular and contains giant-cells.

FIG. 2.—Case I. The same preparation more magnified. The polymorphous character of the cells greatly resembles the tissue which is described later as giant-cell tumor in ostitis fibrosa.



FIGS. 3 and 4.—Case I. Same preparation as in Fig. 2, more magnified. Besides the giant-cells, are polymorphous cells, mainly round, and many of these have a well-defined protoplasm. The intercellular substance is sparse, homogeneous.

FIG. 5.—Case I. A photograph of the tibia sawed through. The extent of the bone cavity is marked by two crosses. Above the articular cartilage may be seen, with the destruction of the spongiosa nearly reaching it.

FIG. 6.—Case I. Röntgen-ray photograph of tibia.

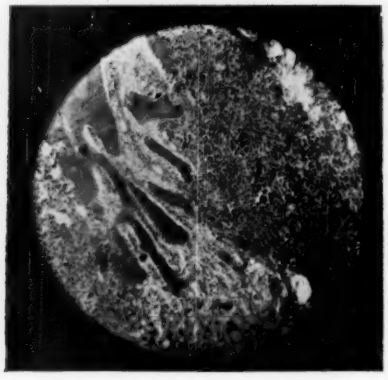


FIG. 7.—Case I. Bone in process of resorption surrounded by non-cellular connective tissue, which must be regarded as fibrous marrow; to the right is shown the same cellular tumor-like tissue as in Figs. 1 to 4.

FIG. 8.—Case II. Röntgen photograph of upper end of tibia.

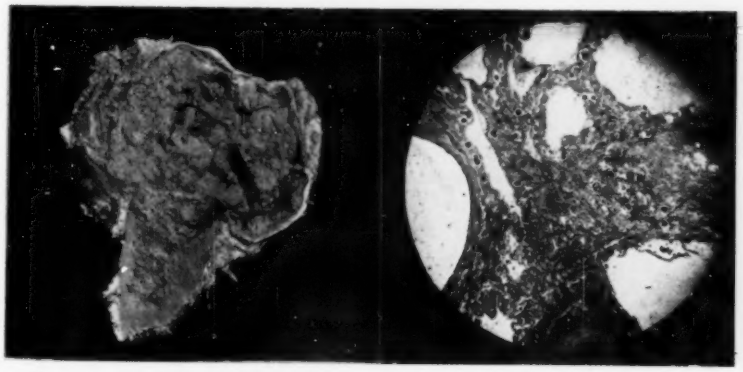


FIG. 9.—Case IV. Photograph of tibia sawed through. The articular cartilage is seen above, below the shaft of the tibia with saucer-shaped depression in the spongiosa. The compact layer is destroyed, its place taken by a growth that has infiltrated the periosteum perforating it. At the right the small cysts mentioned in the text are seen as small light patches.

FIG. 10.—Case IV. Cellular tissue, interspersed with cysts.

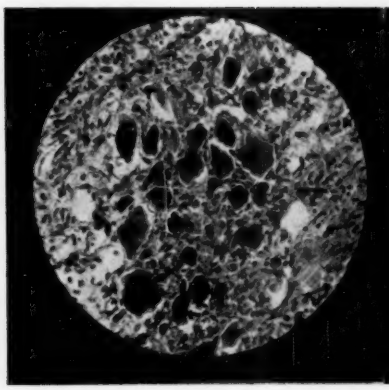
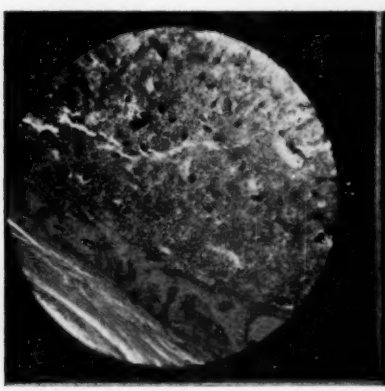
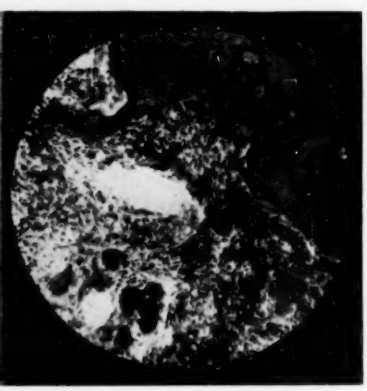


FIG. 11.—Case IV. A cluster of giant-cells; also polymorphous cells, round and spindle-shaped.

FIG. 12.—Case IV. Fibrous area with a cluster of giant-cells.





FIGS. 14 and 15.—Giant-cell sarcoma. Destruction of the bone proceeding from the cellular tumor-like tissue. In the narrow cavity a tissue containing fat without any indication of destruction of the bone and with no osteoclasts.

FIG. 13.--Case IX. Caput fibulæ, swollen, containing cyst of irregular outline; the surrounding bone shell as thin as paper; borderline towards the soft part well defined.

marrow with hemorrhages. Small islands of cartilage with transition to bone are present. Several small cysts are seen in the osteoid substance. They are partly filled with structureless matter, and their walls contain giant-cells.

There is no mention made of any trauma. During two years the patient suffered pains in the foot. Operation reveals an isolated destruction of one bone of the tarsus, with formation of cysts and a new growth of tumor-like tissue. The surrounding tissue was not affected, and the patient was cured by conservative treatment, consisting only in the removal of the diseased small bone. The microscopic diagnosis was given as giant-cell sarcoma, but such interpretation of the preparation is hardly correct. The clinical course of the illness, when in two years only one small bone was destroyed without any damage done to the surrounding soft parts, as well as the favorable result of the conservative treatment, make out a strong case against the assumption that the tumor-like tissue was of a malignant character.

The microscopic picture shows that the cellular tissue is built up by the same polymorphous cells as in the cases of ostitis fibrosa with tumor; there are islands of cartilage with transition to new bone and the few bone fragments left are surrounded by a connective tissue—facts that conform with those of ostitis fibrosa.

The peculiar feature of this case is the profuse growth of new osteoid tissue. This tissue corresponds to the fibrous portions regularly occurring in sections from the tumor-like tissue described in other cases. Cysts, with or without cellular tissue, are found in this tissue.

It would appear that in this preparation the destruction of bone substance starts from fibrillar tissue; so little is left, however, of the original bone that it is impossible to ascertain the point definitely.

From what is stated, it appears that clinically and microscopically the disease must be regarded as non-malignant, and as a case of ostitis fibrosa with giant-cell tumor in a rare localization.

Case VI.—Woman of thirty-nine years (Dr. Holst, Trondhjem). Seventeen years ago the wheel of a trap went across the right leg a little below the knee; in 1908 periodical pain developed in the middle of leg, later in the upper part of tibia, more especially at the external condyle where a protuberance appeared. The protuberance grew, especially after an injury a fortnight before the operation. A swelling was seen in the upper anterior part of the tibia, most pronounced under the external condyle where there was a small soft, pseudo-fluctuating area, while the rest was firm and hard. No effusion in knee-joint.

In the röntgenograph a cavity about the size of a small hen's egg appears in clear outline, in the upper part of the tibia.

Operation, February 22, 1908.—A bony layer, nearly as thin as paper, covered a well-defined cavity in the bone, filled with a yellowish soft tissue that in some places had the consistency of putty, and also contained some reddish-grey matter. The cavity, which had firm long walls, was thoroughly scraped. An opening about as big as a pea in the back wall led to the muscles beyond, which, however, showed no sign of being affected.

April 8: Bone cavity filling up, good granulations. Soon after the patient got up, her wound healed. During the six years since her operation she has felt no ill effects from her illness.

The microscopic examination of the greyish-red matter showed a cellular tissue, the cells closely packed but not in any characteristic order. The nuclei were rich in chromatin, round or oval, and had the appearance of those of connective-tissue cells. The most characteristic feature of the tissue, however, was

the great number of giant-cells, scattered evenly throughout the tissue, with numerous nuclei, generally closely packed together in the centre of the cell; in a few isolated cases the nuclei were at the edges. There were no signs of osseous degeneration or tuberculous arrangement. The growth had a few blood-vessels in some parts, in others the vessels were fairly frequent.

Diagnosis: Myeloma tibiæ (Myelosarcoma—Sarcoma gigantocellulare).

Neither the röntgenograph nor the microscopical preparations have been preserved; thus a more detailed study of them is out of the question.

The history of the case, and most of all the favorable result of a highly conservative treatment, prove the disease to have been of a benign nature. The macroscopic appearance of the tumor tissue, the brownish-red matter, corresponds to the tissue described in other cases. The cavity in the bone was well defined, the compact tissue thin as paper without any pronounced changes in the periosteum, which was perforated at one place without causing any infiltration in the adjoining soft parts. These facts seem to make the accuracy of the microscopical diagnosis rather doubtful.

The yellow putty-like matter does not appear to have been examined microscopically. From some cause or other the tissue had become necrotic and if the operation had been delayed, this tissue would probably have been resorbed and we should have found a cavity surrounded by tissue as described in the other cases. The tissue might also have been of the same description as the yellow tissue in Case II, *i.e.*, young fatty tissue. But there is nothing in the microscopical description that does not conform with the conception that the disease was ostitis fibrosa with giant-cell tumor, and in my opinion that is the correct diagnosis. It is difficult to see any connection between the disease and a trauma 21 years before, but the possibility is not wholly precluded that a hemorrhage in the spongy part at the time may have created a predisposition.

Case VII.—Boy of fifteen years, Dr. Sinding-Larsen. Patient in good health previously. Fell off bicycle June 22, 1916, and broke right upper arm. The Röntgen photograph showed besides the fracture a swelling of the upper end of humerus up to the cartilage of the epiphysis, with cysts with well-defined borderlines. The fracture was located in the lower part of the swelling and one month after the accident a formation of callus was clearly visible in the transitory region towards normal bone. After plaster bandage for four weeks there was consolidation of the fracture.

The operation, July 26, 1916, revealed a cyst nearly as large as an egg filled with bloody matter; the inside of the walls was covered with reddish-brown matter resembling granulating tissue. The bone underneath was smooth; no apparent connection downwards with the marrow cavity. Tamponade.

In section the matter scraped out proved to consist mainly of a poorly cellular myxomatous connective tissue. The bone showed typical alteration, trabeculæ were surrounded by a connective tissue which had destroyed the bone, so that the slow transition to fibrous tissue was clearly visible. Some of the bone fragments were covered with osteoclasts. In a few places there was a tissue with more numerous cells, which latter were polymorphous, some round, some oval, some small and spindle-shaped with abundant intercellular substance. Isolated giant-cells were scattered about.

A considerable alteration of the bone had developed in this patient without any symptoms. A trauma caused a fracture of the weakened shaft and the Röntgen photograph reveals an unknown disease of the bone, viz., a cyst with swelling and considerable destruction of bone. The fracture caused a lesion of the thin bony capsule so that the new tissue in the bone no longer was separated from the soft parts by a bone wall. After four weeks the fracture is fully consolidated, and there is no indication of growth at the line. These facts prove that the disease in the bone must be benign, a supposition which was confirmed by what was found at the operation. Under the microscope bone substance is seen to be replaced by connective and myxomatous tissue, which formed the bulk of the matter scraped out. In some portions there was cellular tissue with polymorphous cells and giant-cells. Without any doubt this tissue is of the same character as the tissue described in the other cases, and in spite of its numerous cells it must be considered as benign.

From a clinical point as well as anatomically we have here a typical case of ostitis fibrosa, but not till a series of sections have been examined did we find those cellular tumor-like areas of the same character as in the other cases where the tumor-like tissue sometimes formed the bulk of the matter taken out. In my opinion this case shows clearly the connection between ostitis fibrosa and giant-cell tumor. The proliferation of cells is slight and there is no giant-cell tumor, but the main feature is the destruction of bone substance. In other cases, as for instance in Case III, the growth of cells is more pronounced, while all the time a decided formation of cysts goes on. In other cases again, the proliferation of cells is so active that the formation of cysts becomes of secondary importance and we have a purely productive process with formation of a tumor-like tissue resembling a giant-cell sarcoma to the point of being mistaken for one. All these cases represent an ostitis fibrosa with giant-cell tumor, the latter more or less pronounced.

Case VIII.—Boy of ten years, Prof. P. Bull. In March, 1916, a small protuberance was discovered by chance on left side of the lower jaw; it grew slowly and was not sensitive. On September 3, a swelling as big as a walnut could be felt on the lower jaw at the foremost molars which was removed the following day. At the incision into the tumor the knife was felt to perforate a thin plate and to enter a cavity filled with softer tissue. No fluid exuded. The cavity was carefully scraped. It was as big as an almond, with smooth walls. Tamponade. The matter scraped out brownish-red and soft.

Microscopically, the tissue is heterogeneous, showing all stages between a connective tissue rather poor in cells and a cellular tumor-like tissue with numerous and large giant-cells. The cells are polymorphous connective-tissue cells, some round or oval, of varying size, as a rule with abundant intercellular substance. Large portions consist of a myxomatous tissue more or less cellular, with a profuse sprinkling of giant-cells. The tissue is infiltrated with fresh hemorrhages. No portion of the bone was available for examination.

On the jaw of a child a protuberance grew slowly without any pain. Six months after the discovery of the tumor operation revealed a cavity as

big as an almond, with smooth walls, as thin as paper in the direction of the mouth and with no changes in the periosteum. This cavity contains a soft tumor-like tissue, which microscopically must be identified with tissue described in the other cases. Here also we see an extraordinary variety of tissue with all stages between fibrous and sarcoma-like tissue with a number of large giant-cells. The greater part of the cells are spindle-shaped, but there are also smaller and larger oval cells, partly with, partly without intercellular substance. There is no stroma, as is usual in the case of a typical tumor, and no infiltrating growth of cells.

The process must be considered as ostitis fibrosa with giant-cell tumor in a rare localization and at an early stage. We cannot yet know as to the final result of the operation but in all probability the conservative treatment was sufficient.

Case IX.—Man of twenty-eight years, Dr. Christensen, Aker Hospital. The patient felt tired in the right lower leg during the previous three months; during the last three weeks pains and a pronounced sensitiveness to pressure above the head of the fibula. No trauma.

The Röntgen photographs (Fig. 13) reveal a cavity, barely as large as an egg the outlines of which are not quite clear, and a corresponding swelling of head of fibula. The bone shell is as thin as paper, somewhat irregular, but not penetrated by tumor tissue in any place.

Operation, September 22, 1916. Soft parts normal, periosteum not thickened; a thin lamella was removed and behind it was a cavity filled with greyish, crumbling, tumor-like tissue, which was easily scraped from the smooth walls of the cavity.

Sections of a series of pieces show a polymorphous appearance: There are large and small fibrous portions with few cells and cellular tumor-like tissue with large giant-cells in great numbers. The cells are heterogeneous, some are rather large, round or oval with vividly colored nuclei and distinct protoplasm, others are smaller or spindle-shaped with abundant intercellular substance. In several places there is a network of tissue of an intensive red color (van Gieson) surrounded partly by a finely fibrous tissue, partly by the tissue just described containing giant-cells. In several places its diffusion into or transition to the surrounding tissue is clearly discernible. At one place a small quantity of calcareous substance is surrounded by a lax, connective tissue which distinctly merges into the network just mentioned. The latter must be remnants of spongy tissue in the head of the fibula.

Sections from the walls of the cyst show destruction of bone in connective tissue with rows of osteoclasts—of which many are giant cells—along the bone fragments. The cellular tissue is seen in many places lying close to the bone, destroying it. On the outside of the bone lamella is formation of new bone starting from the periosteum.

Clinically, the complaint was considered benign and treated accordingly in spite of the fact that the microscope showed the tissues scraped out to be exceedingly rich in cells. The destruction of the bone takes place for the most part in a tissue of few cells, in some places, however, the tumor-like cellular tissue is seen in close proximity to bone. The tissue is homogeneous in so far as the fibrous portions merge successively into the cellular parts. There is no connective-tissue stroma with infiltrating growth of cells.

The cells are polymorphous. In several places along the bone trabeculæ there are giant-cells which must be taken to be osteoclasts. They have the same shape and appearance as have the giant-cells we find scattered in the tissue, a fact that indicates a common origin.

All these facts make me inclined to think that this case also should be considered a case of ostitis fibrosa with giant-cell tumor.

There is a considerable resemblance between this case and Case I. In both the proliferation of cells is so profuse as to make the microscopic picture like that of a sarcoma.

It may be of interest to compare these cases of giant-cell tumor with the following case of giant-cell sarcoma, of decidedly malignant character both clinically and anatomically.

Man, thirty-six years old, two years ago became aware of a small protuberance as big as a pea and hard as bone on the inside of the radius just above the joint. It was removed, but returned five times before amputation was made in November, 1901.

The radius was swollen, its surface uneven with tumor growth on the outside of the periosteum. The articular cartilage was affected. When sawn through a great part of the radius was replaced by a large growth; throughout parts of which were spicula. The sections from the growth present a homogeneous aspect. It is a very cellular tissue of small round or spindle-shaped, atypical connective-tissue cells with abundant intercellular substance. In all parts of the tissue numerous giant-cells are scattered. Sections from the compact bone show the replacement of the bone to proceed from the tumor tissue (Figs. 14 and 15). It is not possibe to demonstrate any fibrous marrow and the destruction of bone proceeding from a connective tissue with few cells.

At first sight we here seem to have before us the same giant-cell tumor described in the preceding cases, but a closer examination soon shows differences that justify another diagnosis, viz., *sarcoma*. The destruction of the bone is evidently due to a growth of cellular atypical tumor tissue. In no place do we find the destruction taking place in a poorly cellular connective tissue or fibrous marrow, as demonstrated in all the previous cases.

The tumor tissue is more homogeneous, with no large fibrous areas, the cells mostly spindle-shaped or small or round. Altogether the case differs widely from what is described as giant-cell tumor accompanying ostitis fibrosa. Clinically this tumor moreover showed its malignant character by repeated recidivations.

The localization of ostitis fibrosa shows that the parts of the osseous system most often affected are those exposed to the heaviest pressure. Thus Wilken found that of 33 cases the femur was involved 13 times, the tibia 7, the humerus 4, and various other bones 8 times. Other authors mention the tibia as most often attacked. Of the nine cases described now the disease had its seat five times in the tibia, once in the fibula, once in the humerus, once in the lower jaw and once in os cuneiforme. In the cylindrical bones the disease is mostly found in the epiphysis.

The patients frequently give a trauma as the cause of the condition. This fact occurs too frequently to be overlooked; it is doubtful, however, whether the real cause is to be found here. As far as I know, no one has

described bone cysts caused by or as a consequence of fractures or infractions. Moreover, contusions of the bones, and more especially of the bones most often affected, occur so frequently that ostitis fibrosa would have to be reckoned among the common complaints if a trauma would produce it, whereas now it must be considered rather rare. Also, general ostitis fibrosa with foci in practically all parts of the osseous system indicates other causes than trauma.

Beneke (1904) tried to explain the bone cysts as arising in the same manner as an apoplectic cyst arises in the brain. Accordingly a trauma would cause a hemorrhage in the spongiosa, with a subsequent destruction of bone substance. After the resorption a cavity would be formed which would not break down on account of the rigid walls. Our experience concerning traumas in the osseous system and Lexer's experiments on animals are decidedly against this view. The bone that shows a formation of cysts after a trauma was not normal before. The disease was already developing or latent in it. v. Recklinghausen thought that the cause of the disease was a disorder in the circulation, *i.e.*, embolism or thrombosis in the finer vessels of the bone. Other authors again supposed the process to be due to bacteria, a virulent species of the common pus microbes. This theory has never been proved, all experiments to cultivate microbes having been negative or at least doubtful. From a purely anatomical point of view the structure of the tissue does not point to the existence of an inflammation in the ordinary sense of the term. It is a task of the future to find the cause of this malady, which must be considered as a general disease of the osseous system, occurring at an early age, most frequently with isolated foci in the epiphyses of the long bones, in later years with multiple foci in the whole of the skeleton.

Now and then in cases of ostitis fibrosa one meets with cartilage. After Virchow's (1876) description of a case of cysts in the humerus with abundant cartilage in the wall, several authors have tried to explain osseous cysts as the results of dissolved chondromas, even in cases where no cartilage was found in the wall. There is no doubt that cysts may be formed within chondromas but this fact is of no importance for the question of the cause of osseous cysts in general. Cartilage is formed contemporaneously with the formation of new osteoid tissue and bone but without any connection with the cause of the process. The cartilage therefore is generally found as smaller or larger "islands" in the osteoid tissue of the new bone.

CLINICAL SUMMARY

The patients are young, as a rule less than 20 years old. Older persons (over 50) are, however, also mentioned as suffering from the disease. The history of the disease remarkably frequently begins with a trauma. Sooner or later after this the patients get rheumatic pains in the injured limb.

Very slowly, sometimes during several years, the bone swells, partly because the main cyst increases in size, partly because of a profuse growth of tissue containing giant-cells; or the tissue softens and cysts are formed

with no swelling of the bone. This state of things may go on unchanged for years. The diagnosis is given as rheumatism, sciatica, etc., until a slight trauma causes a fracture or the bone bends little by little as it becomes too weak to stand the pressure upon it.

The general health of the patients is invariably good. Notice, for instance, Case III, the patient doing his military service with a large tumor of the tibia. Palpation reveals an even hard swelling of the affected bone, not sensitive and with the soft parts moving freely over it. Sometimes it crackles like parchment, the bony wall having become as thin as paper.

The Röntgen photograph is of great help; it is often so typical that the diagnosis is obvious. On the other hand, even a Röntgen expert may sometimes doubt whether there is a sarcoma or not. The typical photograph of a benign osseous cyst shows the latter as one or more well-defined cavities surrounded by a bone shell frequently as thin as paper with no changes or hardly any in the periosteum. The bone may be more or less deformed, swollen or bent.

The description of the osseous cysts may be mistaken for a sarcoma, but in the case of the latter the outline is not so clear, at least not at a stage in the disease advanced enough to offer clinical symptoms. The sarcoma grows more quickly, destroys the bone more unevenly and the periosteal changes come early. Both bone and periosteum are perforated and there is a diffuse and infiltrating growth in the soft parts.

A case of ostitis fibrosa with giant-cell tumor may yield a Röntgen photograph so strongly resembling that described for a sarcoma that a mistake is unavoidable. The slow growth, however, combined with the general good health would argue against a diagnosis of sarcoma and the descriptions would hardly be quite alike.

The outline of a giant-cell tumor is always sharper than that of a sarcoma. If it does penetrate the periosteum the tumor tissue grows out into the soft parts without infiltrating them and bone spicula are exceedingly rare in this tissue.

The Röntgen photograph may be mistaken for other conditions of which the following are the most important: Central gumma, which, however, always shows heavy periosteal deposits. Abscess of the bone as a rule also involves periosteal changes. Echinococci of the bones have distinctly separated bubbles. Tuberculosis, if there is one isolated focus in the epiphysis, may be difficult to distinguish from an osseous cyst. The patient, however, as a rule, is younger than those who suffer from osseous cysts, and before the compact layer grows, as in the case of osseous cyst, the periosteum is affected or perforated and a tuberculous abscess is formed.

Mikulicz has formulated his opinion of osseous cysts as follows:

1. It is a disease of the growing period. Of 24 cases, 20 were under 20 years old, 2 under 30 and 2 over 30. In cases in older individuals it must be considered as carried from younger years.

2. The illness preferably affects the long cylindrical bones, and more especially the parts where growth is strongest.

3. The initial trauma is of some importance. It may date back months or more. The process is altogether benign. The tumor tissue that is found does not metastasize, nor does it return, and in case of spontaneous fracture there is abundant formation of callus with complete cure.

All authors seem to agree that local ostitis is found most frequently in individuals under 20 years of age.

The age of the nine cases described here—16, 35, 29, 28, 24, 20, 15, 10, and 1 unknown—with an average of 26 years—is somewhat higher than that which others have stated, but the cases are too few for any valuable deduction from them on this point. It should be borne in mind though, that of nine cases, eight were cases of tumor-forming ostitis fibrosa.

The *treatment* is exclusively surgical, but as conservative as possible. Where there is a smooth-walled cyst with serum-like contents, it is sufficient to remove the latter, scrape the walls carefully and push in the thin bony shell. Then the periosteum will form callus in abundance and the process is healed. If the cyst has been so large that the operator breaks off the continuity of the bone, extension must be employed until the Röntgen photograph shows an adequate formation of callus.

If the cavity contains tumor tissue this must be scraped out carefully, as an insufficient scraping may result in recidivation. During the scraping profuse bleeding may occur which may be difficult to stop. The operation should therefore always be undertaken with Esmarch's method, because in that way the scraping is done most easily and with greatest safety, the danger of bleeding being avoided. The cavity may be filled up with fatty tissue transplanted from the patient himself, as the cavity often heals but very slowly by granulation.

The periosteum must be saved as much as possible. Should the bone be destroyed to such an extent that a total removal of the tumor tissue is impossible, the diseased part of the bone must be resected while all healthy periosteum is preserved.

To prevent any shortening of the bone, either bone may be transplanted or ivory stick inserted. Both proceedings have proved successful; the periosteum has formed callus in abundance after the resection.

It is deplorable that microscopical examination sometimes permits only a probable diagnosis. The interpretation of the preparation in question will always depend on a personal opinion. There has not yet been discovered any test whereby the diagnosis may become absolutely certain either way when the cases are doubtful.

The operator therefore must take upon himself the responsibility of deciding whether to take the usual consequence of a diagnosis of sarcoma, when he is aware of the fact that the original disease may be ostitis fibrosa, or whether the clinical facts of the case justify a conservative treatment—nay, even demand it.

An exarticulatio femoris in young persons is a serious thing indeed,

and both patient and surgeon will benefit by running the risk of non-radical treatment of a sarcoma if such really be present.

If the case is one of malignant tumor the prognosis is doubtful even after a radical operation, *e.g.*, exarticulatio femoris, and if the disease is benign, the surgeon has unnecessarily made a cripple of his patient, while a conservative treatment would have ensured complete health.

SUMMARY

Ostitis fibrosa with formation of tumor is not very rare. It occurs most often in young individuals, but may also be found in persons of fifty to sixty.

Trauma appears in many cases to be an etiological factor, although we are unable to explain how it can cause the disease or influence its genesis.

The course of the disease is chronic with comparatively slight symptoms, rheumatic pains, and a slow swelling of the affected bone. The general health is good. Spontaneous fracture or bending of the bones may occur.

The Röntgen photograph is often typical, but sometimes it is impossible to decide whether the diagnosis might not with equal correctness be given as sarcoma.

The treatment is exclusively surgical, all diseased tissue must be carefully removed albeit with an obligation to be as conservative as possible.

When the bone is opened, the cavity is found to be more or less filled with a brownish-red or sometimes yellowish, crumbling tumor tissue. The borderline is, as a rule, sharply drawn, although the same tissue may be found outside the periosteum.

Under the microscope the destruction of the bone is seen to take place in a connective tissue with few cells, *i.e.*, fibrous marrow. Formation of new bone is also seen. The tumor-like tissue is built up partly by very polymorphous cells with numerous and uncommonly large giant-cells, partly from a fibrous tissue with few cells. Mucous tissue with softening and formation of cysts also occurs.

It is sometimes difficult to decide that the diagnosis is not sarcoma.

The disease is benign even when the periosteum is perforated.

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REGENERATION OF BONE

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INTRODUCTION

The transplantation of bone is one of the very important branches of reparative and conservative surgery. The cardinal principles governing the successful transplantation of bone were laid down by Ollier, but there still are divergent views both as to the best technic for bone transplantation and the vital processes by means of which the reproduction of bone takes place.

The reproduction or regeneration of bone is the basic phenomenon upon which a successful transplantation depends, and it is in the hope of shedding more light upon this process that the experiments recorded below were performed by the authors.

A summary of the normal development, growth, and structure of bone along with a brief review of the literature on bone transplantation will be given before proceeding to the results of our work.

There are two types of bone found in man, cartilage bone which develops on a cartilaginous basis, and membrane bone, which develops directly from connective tissue without an intervening cartilaginous stage. The mode of development of cartilage bones only, and not of membrane bones, will be described here, because most of the skeleton is composed of bones of this type and most of the experimental research on transplantation has been done with cartilage bones. Previous experiments have yielded divergent results both as to the fate of the transplanted bone and the regenerative power of its various constituents.

THE DEVELOPMENT, GROWTH, AND STRUCTURE OF CARTILAGE BONE [1]

A description of the development of one of the long bones will serve as an illustration of the embryonic development of cartilage bones.

The site which is later occupied by a mature, fully developed bone is first filled in by embryonic connective tissue with closely packed cells. This tissue is transformed into cartilage. The cartilage is non-vascular, but is surrounded by a vascular, fibrous membrane, the perichondrium, which develops into periosteum.

[1] This description is taken in the main from Cunningham's "Text-book of Anatomy," Fourth Edition; and Quain's "Anatomy," vol. ii, Part 1, "A Text-book of Microscopic Anatomy," by E. A. Schafer.

Next, two changes occur simultaneously: (1) The cells at the centre of the cartilage become enlarged and flattened and pile up in longitudinal columns radiating from the centre towards the ends, and the matrix becomes hardened by a granular calcareous deposit. (2) The cells of the inner lining of the perichondrium assume a flattened or cuboidal shape and become osteoblasts, constituting *the osteogenic* or *cambium layer,* and form a bony layer on the surface of the cartilage.

Bone is formed from osteoblasts by the deposition of inorganic material about each cell. The osteoblasts are thereby included in small spaces or lacunæ and are then called young bone cells. These cells are not surrounded by a solid calcified wall, but small channels called canaliculi, which arise from the lacunæ, radiate irregularly through the surrounding matrix, and anastomose with canaliculi from neighboring lacunæ. The cells within these spaces also send filamentous processes into these canaliculi, thereby giving the cells a spidery appearance.

The next step is a migration of the subperiosteal vascular and osteoblastic tissue into the centre of the cartilage, followed by an absorption of the calcified cartilage and by formation of marrow spaces. These spaces are filled by jelly-like embryonic marrow and are lined by osteoblasts. This lining of osteoblasts is known as endosteum, but it should be noted that it arises from periosteum. Bone is deposited around these marrow spaces by an advancing line of osteoblasts. The osteoblasts follow and surround the blood-vessels and deposit bone in layers about them. As layer after layer of bone accumulates about the vascular structures, ramifying, communicating trabeculæ of bone are formed, and the large spaces between them become narrowed into intercommunicating channels. While this process is taking place layers of bone are also being deposited beneath the periosteum, but this cortical deposit is penetrated by numerous blood-vessels which communicate with those in the medulla.

At about this time large cells, which are usually multinuclear, appear along the edges of the bone which has been formed. Their action is the absorption of bone and they are termed osteoclasts. In performing their function they excavate hemispherical pits known as foveolæ of Howship.

Bone absorption is necessary for the growth of bone. The absorption occurs most actively in the centre, or medulla, of the bone, though to some extent it also occurs in the cortical portion. By this means the marrow spaces which have, in the meantime, been filled with cancellous bone are reformed as the secondary marrow space. The cortical bone is being removed from the centre, and while this is occurring bone is being deposited in lamellæ upon the outer cortical surface, thus bringing about lateral growth or increase in width. Growth at the ends occurs by an advancing deposit of bone in the growing cartilage.

At about this stage additional centres of ossification develop in each end of the bone. These are called epiphysial centres and are situated between the end, or epiphysis, and the shaft, or diaphysis. The epiphysial line is formed by blood-vessels or vascular loops advancing into the epiphysial carti-

lage and carrying with them endosteum or osteoblasts. This osteogenetic tissue then becomes completely separated from the osseous shaft by a portion of cartilage which remains. This cartilage persists in some places until after puberty, and continually grows, and by being continuously replaced by bone causes the longitudinal growth of bone.

The intercommunicating channels, referred to as arising in the marrow spaces and in the bone deposited by the periosteum, are lined by osteoblasts and deposit concentrically at their periphery successive lamellæ of bone. By this process the channels become reduced to very narrow canals, called Haversian canals. These Haversian canals therefore contain blood-vessels and are lined by osteoblasts. The systems of concentric bone lamellæ are joined together by irregular systems of lamellæ. Upon the surface of the shaft, completely around all these systems, additional concentric lamellæ are deposited beneath the periosteum by the cambium, or osteogenic layer of periosteum.

Eventually the marrow spaces become converted into a central canal filled with mature marrow[2] and containing only a few trabeculæ of bone. Around this central canal is a layer of interlacing bone trabeculæ forming cancellous bone, and all of these trabeculæ are covered completely by a layer or layers of osteoblasts. Outside of this is found the compacta, or cortex, the Haversian systems and lamellæ of which have been described above. The surface is covered by the osteogenic or cambium layer of osteoblasts, which can be considered as lying between the cortex and the fibrous periosteum, or, one might say by way of comparison, that the cambium layer lies between the tree and its bark. It is this similarity which has given rise to the name cambium layer of the periosteum.

The blood supply of the bone is furnished (1) by numerous minute nutrient arteries (mentioned above) which penetrate the cortex from the periosteum through the Haversian canals; (2) by one or more larger nutrient arteries which penetrate the cortex usually at about the centre of the shaft and enter the medullary canal.

The important points to be emphasized are:

(1) All cartilage bone is produced by cells arising from the osteoblasts lining the periosteum and is deposited in preformed cartilage, the latter being absorbed.

(2) The endosteum is formed of osteoblasts which arise from those lining the periosteum, and osteoblasts also extend from the endosteum and the osteoblastic (cambium) layer of the periosteum into the Haversian canals and line them.

(3) Cartilage which is about to be ossified undergoes certain changes, among which is an enlargement and flattening out of its cells, with their arrangement into columns at right angles to the plane of bone growth.

(4) Bone cells (not osteoblasts) are enclosed in bony lacunæ which intercommunicate by means of canaliculi.

[2] The development of marrow will not be discussed, as it has nothing to do with the growth of bone.

(5) None of the bone cells are in immediate contact with blood-vessels or capillaries and their only nourishment must be plasma obtained through the canaliculi.

(6) The above described method of bone growth is known as growth by absorption.

In addition, several other things of importance may be mentioned. Young lacunar cells which have just been formed from osteoblasts may divide and form a very limited amount of bone. When bone develops in this manner immediately in apposition to older bone, the older bone may be absorbed and replaced by this young bone. The method by which bone is absorbed in this instance is not known, but it is not accomplished by the aid of osteoclasts. Apparently it occurs in some direct manner which appears somewhat like solution of the bony structure. This type of bone growth or bone substitution is called creeping replacement.

Most bone, however, arises directly from osteoblasts. *Fully developed bone cells, in the accepted sense of this term, that is, cells within well calcified lacunæ, have never been shown by microscopical observation to have divided and formed new bone.* Undoubtedly most normal bone is formed by the endosteum and cambium layer of the periosteum and only to a less degree by osteoblasts lining the Haversian canals.

REVIEW OF LITERATURE

The earliest experimental work bearing upon bone transplantation was done by that great master of bone surgery, Ollier, in 1867. He did not make a histological study of his transplants, nor did he have the aseptic and antiseptic methods of operating that make the work of to-day so sure of successful issue. His conclusions on bone transplantation were all based upon macroscopical observation, and up to the point where microscopic study is necessary they have been found absolutely true. Briefly stated, they are as follows:

1. For the transplantation of bone there is a fundamental difference in the use of autogenous, periosteum-covered grafts, on the one hand, and every other kind of bone material, on the other.

2. Only the former manifests an increase of thickness after a rapid fibrovascular connection with its bed, and it is the increase of thickness which is a sure indication of continued vitality of the transplanted bone.

A true graft of bone (*i.e.*, a graft that retains its vitality) is possible only after transplantation of living, autogenous periosteum-covered bone, and this is in virtue of its living periosteal covering. This latter, after transplantation, remains alive, *and thereby maintains the life of the transplanted bone.* It is, therefore, the most important factor in bone transplantation.

3. Every other kind of bone when transplanted dies, if it is not already dead at the time of its implantation. All of these varieties of transplants become foreign bodies, and either remain intact and encapsulated at the site of implantation, or they are resorbed, the latter process often being hastened by the blood-vessels which penetrate into them. If such material is im-

planted in a bed that is itself bone-producing, it is possible, under favorable condition, for it to be replaced by new bone formed from this bony bed.

4. Where it is desirable to restore bony continuity after the removal or destruction of bone, one must make use of living, autogenous, periosteum-covered bone grafts.

These conclusions were accepted and remained classical until the work of Radzimowsky, 1881, and Bonome, 1885. Both these experimenters contended in contradistinction to Ollier that all transplanted bone tissue dies even when it is autogenous and covered by living periosteum, but that the periosteum lives. As proof of their contention they instanced the death of the bone cells as shown by the change of the latter in morphology and staining qualities.

Radzimowsky demonstrated in the cranial and long bones of birds and mammals that bony union between bone fragments and adjacent bony tissue easily takes place irrespective of whether the periosteum is preserved or not, over such fragments. Such bony union, however, may be considered no evidence of enduring life in the fragments of bone, and further, the presence of blood-vessels in such fragments is no evidence of life therein, inasmuch as dead bone may also be permeated by blood-vessels from its vicinity. Microscopic examination of such bone fragments showed that they were dead, for the bone cells were dead. On the other hand, he demonstrated that the periosteum lived and produced new bone. Therefore, he concluded that when living periosteum-covered bone is transplanted, the bone tissue proper dies, but the periosteum lives and produces new bone that is deposited not only on to the surface of the transplanted dead bone, but also into its lacunæ and enlarged Haversian canals.

Bonome, working with rats, reached conclusions similar to those of Radzimowsky, and also showed that when fracture of the bone occurred the bone in the immediate vicinity died, as was shown by the staining qualities of the bone cells. As to the ultimate fate of the dead bone he concluded that this is resorbed and replaced by new bone which is formed from the osteogenetic layer of the periosteum.

The work of these two experimenters established, with the aid of microscopic study, the first great advance after the pioneer investigations.

No new advances or contributions to the subject of bone transplantation were made until Barth, 1893, reported the results of his experiments. He likewise found that when autogenous, living, periosteum-covered bone is transplanted the bone tissue dies, and in addition he makes the important assertion that he could not convince himself that the periosteum or marrow fared any better than the bone tissue proper. He deduced from his experiments, which were performed on the skull, that the transplanted periosteum also died, and was replaced by the growth of periosteum from adjacent bone which extends over and covered the graft. He concluded, therefore, that inasmuch as all the parts of a living periosteum-covered bone graft died, it is immaterial whether we use, for transplantation purposes, bone covered or uncovered by periosteum, or decalcified or macerated bone. He thought

that the transplant was a sort of splint, to be gradually replaced by new bone formed from the surrounding bony tissue. Briefly stated, the conclusions of Barth were as follows:

1. Fragments of any kind of bone like other foreign bodies can be implanted into the living tissues.

2. All varieties of bone material are similar in the process of their implantation and of their bony replacement.

3. When living bone with periosteum is transplanted, all of its integral parts die.

4. Therefore, all varieties of bony substance are foreign bodies at the outset, or become so, and are *gradually replaced by new formed bone from the adjacent bone-producing tissue.*

These conclusions, radically different as they were from those of Ollier and his followers, were accepted, and for the next decade surgeons gave up altogether bone grafting and used macerated or decalcified bone or other foreign material to fill gaps in the continuity of the skeletal system. The lack of success of these procedures was brought out in the German surgical congress of 1902, when the subject of bone transplantation was brought up for discussion. It was the general opinion at this meeting that though the experimental conclusions of Barth might be true, the same did not hold in practice. The opinion expressed seemed to be unanimous—that the best results were obtained when living, autogenous, periosteum-covered transplants were used. Even Barth had to concede this in the light of his subsequent experience.

In order to gain more information on the subject Axhausen took up the work anew, and by his experiments and histological examinations placed the whole subject on a firm basis. His conclusions were as follows:

1. The conclusions of Barth as to the relative equal value of all varieties of bony material for transplantation cannot be upheld.

2. The first law of Ollier, namely, that there is a fundamental difference, as regards transplantation, between the use of living, autogenous periosteum-covered bone, and every other kind of material, is true in other animals as well as in the human subject.

3. The difference lies not, as Ollier thought, in the survival of the life of the transplanted bone tissue proper, for most of this dies, only a few cells persisting, and is replaced by new bone, but exists in the periosteum which survives.

4. This surviving periosteum produces the new bone. When the transplantation is made into a bone-producing bed the new bone formation from the periosteum is not marked, for this bed is alone sufficiently able to fill the gap in its substance. But in the case of transplantation into a defect of the long bones this periosteal new bone formation, together with that from the marrow, are the only means for filling the gap.

5. The survival of the bone-producing periosteum established a rapid and intimate vascular connection between the transplant and its bed, and in virtue of its bone resorbing and bone forming power this surviving periosteum

forms an intimate connection with the underlying transplanted dead bone. This is in marked difference to the loose fixation of the transplant in the tissues when bone uncovered by periosteum is used.

6. The survival of the marrow has no dependence upon whether the graft is covered or uncovered by periosteum.

These experimental conclusions were in accord with the empirical ones reached by practical surgeons, and since these classical labors of Axhausen the surgical world has accepted, until recently, the fundamental law of Ollier, namely, that for a real bone graft we must use an autogenous portion of bone covered by living periosteum.

The truth of this law of Ollier has been disputed by William MacEwen in a monograph entitled " The Growth of Bone," published in 1912.

MacEwen claims that periosteum is merely a limiting membrane, which has not the capacity to form bone, but serves only to confine the bone within bounds and prevents its overproduction. He believes that bone has the power to reproduce itself, if it receives proper blood supply, and is the only tissue from which new bone can grow.

There are two important criticisms which can be made of MacEwen's work:

1. In spite of his large number of bone transplantation experiments there is an almost complete absence of microscopical study of the grafts. Therefore, evidence, which is only revealed by the microscope, that the *bone cells* of the transplant are alive and that regeneration has originated from them and them alone, is lacking.

2. He concludes that transplanted bone is alive if it has contiguous connective tissue adherent to it and gives with the X-ray a shadow almost as dense as that of the original living bone. This, however, has been disproved by Küttner, who showed that this occurred in homogeneous human transplants of large portions of bone, such as the head and upper third of the femur, and still on microscopical examination all of the bone cells were dead and no osseous regeneration of any sort had taken place from the transplant.

Since MacEwen's monograph several important contributions have appeared, in the main contradicting his conclusions.

Mayer and Wehner, from a carefully planned series of experiments of transplants of periosteum, subperiosteal resections, cap implantations, and bone transplants, conclude that all of the results " combine to emphasize the osteogenetic function of the specific osteoblastic cells (of periosteum, endosteum, and lining Haversian canals) and the inability of the adult bone cells to form new osseous growth.

Their cap experiments are especially conclusive.

They note the part played by the osteoblasts lining the Haversian canals in regeneration of bone, but do not assign to these cells the importance they probably deserve. They demonstrate, however, that it is the outgrowth of these cells from the Haversian canals which forms new bone about free transplants of cortex devoid of endosteum and periosteum, and that this is

not due to the metaplasia of the surrounding connective tissue according to Baschkirzew and Petrow.

Mayer and Wehner also have shown that in the replacement of old bone by new bone the process described by Marchand and Barth as "creeping replacement" is of equal, if not greater, importance than the well recognized one of absorption and substitution.

Phemister's investigation adds additional experimental evidence to that of Mayer and Wehner. In some very well selected experiments he demonstrated that in artificial or acquired fracture in the middle of a transplant of a portion of the entire shaft of a long bone, new growth of bone occurs at the fracture, whereas the bone between this fracture and the ends of the transplant (which are in contact with the original shaft) is dead. This new bone arises mainly from endosteum and periosteum. Phemister believes, however, that a few bone cells of the compacta do proliferate and form new bone. A careful perusal of his protocols does not reveal any definite evidence of this. It would seem that here he is dealing with osteoblasts of the Haversian canals as noted by Mayer and Wehner and not with bone cells. The healing of these fractures in the transplant, of course, completely disproves the idea that bone reproduction occurs only through "osteoconductivity," which was held originally by Barth and at present by Murphy and by Davis and Hunnicutt.

Smith also reached the conclusions from his experiments that mature bone cells are end products and that osteogenesis is limited to the osteoblasts.

OUTLINE OF EXPERIMENTS

The object of the experiments to be reported was to determine the fate of the various component tissues which make up bone, when these were transplanted either singly or in different combinations, and also to find out under what circumstances these transplants produced new bone, and which element or elements were capable of generating bone.

The following experiments were performed on twenty-two full-grown cats; the transplants were autogenous, and the material was taken from the tibia. In all cases primary union was secured at the wound over the tibia and at the site of transplantation. A few of the transplants were placed on the surface of, and within the substance of, the spleen, or subcutaneously. Most of them, however, were placed upon the costal cartilages, after these were either scraped bare of perichondrium or else after removing a wedge from the cartilage or cutting away its outer half. An attempt was made at first to lift up the perichondrium and insert the transplant between it and the cartilage. The perichondrium was found so intimately bound down that it was impossible to do this without tearing it severely, so this method had to be abandoned. The transplants were held in place by two black silk ligatures which were placed at the two ends and around the cartilage. With a sharp, full curved needle, the ligature could be passed around the cartilage without entering the pleural cavity. In order to determine the nature of the material transplanted, pieces of tissue were removed from each transplant as soon

as it was secured, placed in 10 per cent. formalin and examined microscopically. A series of control experiments was performed by injuring the cartilage in a number of ways, in order to determine if any impetus or tendency to form osseous tissue could be given cartilage by manipulations similar to those necessary in using it as a site for transplantation.

Cartilage was chosen as the site of most of these experiments for several reasons. It has been shown that tissues differ in the degree of their capacity for serving as a satisfactory medium or soil for the implantation upon them of other types of tissue. Certain structures, such as the spleen, serve in this capacity very poorly, and in fact the spleen seems to have a destructive action on grafts placed within it. Subcutaneous or intramuscular situations have been the ones most often and most successfully used in transplantation experiments. There are also certain special affinities which exist between tissues, as, for instance, with testes and ovaries. Stockard has shown that these organs serve well as a base for transplantation of grafts taken from each other, whereas grafts from either do very poorly on other tissues. Consequently because of the intimate relationship which exists between bone and cartilage, both during the process of growth and in the stage of full development, it was thought that it would be interesting to note in what manner cartilage would serve as a base for transplants of different elements of fully developed bone, and whether it still retained its ability to readjust its own elements in the peculiar manner which occurs in the laying down and growth of enchondral bone.

Also one of the requisites for the successful transplantation of tissue is that the graft should be rapidly vascularized. For this reason transplants are usually made subcutaneously, intramuscularly, or into parenchymatous organs. Cartilage, however, is nonvascular, and it was thought that transplantations upon this would prove a severe test of the regenerating power of the transplanted bone, which could not get its vascular supply from the cartilage but would have to obtain it from only one side which would lie in contact with the connective tissue. In addition, because of the freedom of the cartilage from blood-vessels, if the bone graft did grow in the direction of the cartilage, it would furnish a good opportunity to observe just which element or elements of the graft proliferated.

MATERIAL AND METHODS

The material for the transplants was obtained in the following manner:

The anterior surface of the right tibia was exposed and all tendons and muscular attachments cut away, care being taken not to injure the periosteum. The periosteum was obtained from the entire surface exposed, by outlining a long quadrilateral piece with the scalpel, then lifting it up at one end with a fine forceps, and teasing it away from the bone with the handle of the scalpel. It always peeled away very easily and no macroscopic bone came away with it. The question as to the nature of the cambium (osteogenetic) layer, or portion of this layer, which was lifted off with the periosteum is discussed later. Next, with a gouge chisel, thin layers of cortex, from 1 to 3

mm. thick, were removed, care being taken not to enter the medullary cavity. It was assumed that a portion at least of the cambium layer remained upon the cortex, and for convenience the pieces of the cortex taken in this manner are called cortex plus cambium. To obtain pieces of cortex alone, the surface was first thoroughly scraped with a heavy scalpel, and then the pieces were removed with a gouge. Cortex covered by periosteum was obtained by outlining with a scalpel an area of periosteum about .5 x 1 cm. Then the cortex beneath this, with the periosteum still adherent, was removed with a gouge chisel. Care was taken not to enter the medullary cavity so as not to include endosteum.

The transplants called cortex plus endosteum are simply pieces of cortex, where the gouge was allowed to enter the medullary cavity and remove in addition a portion of the medulla.

Portions of these different types of transplants which served us as controls showed uniform microscopical pictures, and need not be described repeatedly under the different experiments, but can be taken up collectively here.

Periosteum Control-Serial Sections.—Sections are made up of the usual connective and fibrous tissue, but along the edge corresponding to the cambium layer, the connective tissue is rather compact and the cells are arranged parallel to the surface. A portion of the surface which faced the cortex is lined by cells which resemble the adjacent connective-tissue cells, but at the same time present an appearance somewhat similar to endothelium. In other places, these surface cells are slightly larger and more rounded and seem to differentiate themselves from the connective-tissue cells immediately beneath. This special layer of cells which constitutes the cambium layer is found only over portions of the surface, occupying about half of its extent. The remainder of the surface is made up of bare connective tissue.

Cortex Control.—This is made up of typical dense cortical bone. The Haversian canals are small, most of them the size of capillaries. (Much smaller than in any of the transplants described below.) The edges are everywhere devoid of connective-tissue cells or any cells similar to the cambium layer of the periosteum described above. Also the edge to which the periosteum was attached, and where the cambium was scraped away, is slightly uneven, as though the surface of the bone had been scraped away.

Cortex plus Cambium Control.—The edge from which the periosteum has been removed is smooth, and in places the cortex is bare, whereas in other places there is adherent to the cortex a small amount of loose areolar tissue. At these latter places, the cells immediately next to the cortex are drawn out and flattened, and have somewhat the appearance of endothelial cells, and are similar to those of the cambium layer found lining the periosteum described above. Immediately beneath this layer of cells the superficial cortex does not exactly resemble the deeper portions, staining somewhat differently, taking a slight diffuse hæmatoxylin stain, and its lacunar cells are closer together. The nuclei of the lacunar cells immediately beneath the cambium layer are drawn out and stained densely, and are identical with

those of the cambium; whereas the nuclei of cells further away are round or oval in outline. A number of nutrient vessels spring from the cambium layer and enter the cortex at an angle, and their canals are sparsely lined by the same type of cells which are immediately adjacent to the cortex and which form the cambium layer.

Cortex plus Periosteum Control.—Shows cortex covered by periosteum, these structures being identical with those described above. The cambium or osteogenic layer is similar to that described under cortex plus cambium, only it is thicker and made up of more of the same type of cells. In one series of sections, whereas the lacunar cells immediately beneath the cambium are similar to the cells of the cambium layer, after a distance of one or two cells into the cortex the lacunar spaces are larger and their cells are also larger and more oval and more vesicular, so that these cells, taken altogether, have the appearance of young lacunar cells. (These are somewhat similar to those seen in the new-formed bone in the transplants to be described below.)

Cortex plus Cambium plus Endosteum Control.—These transplants are made up of cortex and cambium identical with those described above, and in addition a portion of the medulla of the bone made up of marrow spaces filled with marrow and subdivided by trabeculæ of bone. The marrow spaces are lined by flattened cells somewhat endothelial in type, identical with those forming the cambium layer. These cells are seen dipping down into the Haversian canals and lining them.

GENERAL DISCUSSION OF RESULTS

Experiments with Transplants of Periosteum.—Twenty-five periosteal transplants upon costal cartilage were examined at periods from 7 to 389 days. All showed active bone formation. One subcutaneous transplant after 77 days showed bone, one on the surface of the spleen showed bone after 82 days, but one in the depth of the spleen for the same period showed nothing but a scar. This is in accordance with the experiments of others with different tissues, and shows the tendency of spleen to absorb foreign tissues.

The process of growth of bone from these periosteal transplants has therefore been studied at such intervals that a definite conception may be formed of the manner of its occurrence.

In the youngest transplants (7 days) there is found in the midst of granulation tissue, an extremely young osteoid tissue which is in contact with the osteogenic layer of the periosteum. The next stage is found after about 28 days, where young bone is seen as branching columns, covered by a continuous line of osteoblasts. Here the lacunar cells are just about formed and are large, with large, oval vesicular nuclei. From this stage on, there occurs in older transplants well formed bone, with all of the characteristics of bone. The lacunæ are fully developed and are grouped concentrically around Haversian canals, and also irregularly disposed between these concentric systems. At a distance from the periosteum instead of canals are found larger spaces which are irregular in shape and are first filled with blood-vessels and delicate granulation tissue, and lined by osteoblasts, and

are later occupied by genuine hæmatopoietic marrow (sometimes admixed with fatty marrow), composed of myeloblasts, myelocytes, megalokaryocytes, megaloblasts, etc. When this new-formed bone is in contact with cartilage it almost invariably invades it in the same manner as enchondral bone invades its cartilaginous matrix, in the normal development of bone, *i.e.*, in the manner described in the protocols as epiphyseal line formation. It would seem from this that cartilage is an excellent medium to accommodate the growth of bone, and that even though it is nonvascular, bone will grow into it and carry its nourishment along with it.

The older the transplants the more calcified they are and the more the lacunar cells assume the appearance of adult bone cells, their spaces and nuclei being smaller and more elongated, and the latter also staining darker.

There is one observation of importance concerning the young lacunar cells which are not yet in a bony matrix but are away from any layer of osteoblasts. The same process of amitotic division and growth is found as was described by Mayer and Wehner. It seems definite that these young cells proliferate in this manner and so account for some of the production of bone. They are found crowded together in areas, in the midst of well developed bone. Here the lacunar spaces are somewhat larger than elsewhere and in some of the areas are in the midst of a matrix which partakes of the properties of both bone and cartilage, for with the hæmatoxylin and eosin stain it has the appearance of bone but stains bluish, like cartilage. Nuclei which are much elongated, indented, or figure-eight in shape, are relatively common in these lacunar spaces, but two nuclei in a single space are seldom seen. Young lacunar cells which lie close to one another or are barely separated by a very thin partition and which appear to have just divided are relatively frequent. Therefore, taking all these facts into consideration, it must be recognized that this is one manner of bone growth. This growth of bone is from young, immature lacunar cells which have just developed from osteoblasts and whose lacunæ are not yet formed by calcified osseous material. It is this type of growth which occurs in bone transplants and in the development of bone and causes the " creeping replacement " of Marchand and Barth. We have never observed this or any other manner of growth proceeding from adult bone cells.

The source of origin of the hæmatopoietic marrow and its method of development is another point of interest and needs further study for its elucidation. The transition has gradually progressed from (1) Haversian canal containing a blood-vessel with a wall formed of a single layer of endothelium and a layer of osteoblasts between the vessel and bony wall, (2) a larger space containing in addition delicate connective tissue, and, finally, to (3) a completely developed marrow. Whether this process of the development of marrow has to do with the histocyte or the endothelium or the osteoblasts is a problem for further investigation.

The manner in which cartilage serves as a medium for bone is remarkable in that it is identical with the embryologic development of bone in cartilage. The reason why the cartilage cells arrange themselves in columns

at right angles to the line of advancing bone has never been explained. This method might serve as a means to attack the problem.

In the older transplants bone absorption is taking place as well as bone growth, for osteoclasts are found at various places along the periphery of the new bone and also of the marrow spaces.

Many of these transplants could not be identified macroscopically as bone, and certainly most of them would not have thrown a shadow with the X-ray. Therefore, it follows that in all experiments of this kind the end result must be carefully controlled by microscopical examination, and where this is not done the conclusions arrived at are based on incomplete evidence.

It is inconceivable that after the careful microscopic examination with negative findings of control pieces of periosteum any bone cells could have been adherent to these transplants. Therefore, the conclusion must be drawn that the bone grew from osteoblasts which form the osteogenic layer of the periosteum and did not arise from bone cells. The fact that the control pieces of periosteum were lined only in places by osteoblasts and not over their entire extent explains why bone did not always spring from the entire surface of the periosteum.

Transplants (of Cortex minus Cambium, Cortex plus Cambium, Cortex plus Cambium plus Endosteum, Cortex plus Periosteum).—Although some of these transplants were in place in the cats as long as 250 days, and were comparatively small pieces, not more than 2 x 3 x 10 mm., none were completely absorbed in that time. Many of them which showed microscopically either well formed bone or growth of bone were too small to have cast a shadow with the X-ray.

The bone or cortex of all the different types of transplants showed the same process, and the nature of this would explain the discordant results which have been reported about transplantations and the osteogenic power of bone.

The transplants removed after the shorter intervals show that most, but not all, of the bone cells are dead and therefore unstained. Those cells which are stained, however, are situated near sources of nourishment (by diffusion), such as the edge of the transplant, the periosteum, or Haversian canals. After a somewhat longer interval there are fewer stained bone cells, but even these have small, irregular, darkly-stained nuclei. In the oldest transplants the tracing of these cells is interfered with by other processes which are going on, but always a certain number of these cells are seen, which are undoubtedly the original cells transplanted, and can be differentiated from the young bone cells present. Therefore it must be as Axhausen contended that, whereas many, if not most, of the bone cells transplanted die, some persist and live. Although carefully examined, none of these adult cells which persist were ever found in any place in the transplant either dividing or giving rise to new bone.

The blood-vessels in most of the Haversian canals evidently, very soon after transplantation, join with surrounding blood-vessels, for their walls are made up of living cells which stain normally, and they contain blood-

cells which are normally stained and alive. The cells of the vessel walls must have been kept alive in the meantime by the blood which was in them or by plasma which diffused in from the tissue next to the transplant. Some canals are empty or contain abnormally-stained blood-vessels and blood-cells which are dead. Very soon after transplantation the Haversian canals enlarge and are found lined by osteoblasts, though a few osteoclasts are also found at this stage. But the absorption of the bone around the canals seems to occur largely in a direct manner and not by the aid of the osteoclasts.

Almost simultaneously with the enlargement of these canals is found a formation at their periphery of a ring of young bone composed of young bone cells. Soon this ring is several cells thick and is found progressing into the bone originally transplanted, the canal becomes progressingly larger. These young cells then proceed more or less irregularly, and, where the canal is near the surface of the transplant, they gain the surface and spread out over it.

This process of growth from the osteoblasts lining the Haversian canals is a very active one and is seen replacing all, or almost all, of the bony transplants and spreading out beyond. These young lacunar cells are also seen dividing just as they were in the bone formed from periosteal transplants. As there are no osteoclasts between them and the original bone which is being absorbed, the absorption must be accomplished by them, perhaps through a biochemical action, and they replace the old bone by "creeping replacement." It is conceivable that they might slip into the empty lacunar spaces of the original bone, but this was never observed.

The transplant, cortex without periosteum, removed after an interval of 53 days (see Fig. 7) is an excellent illustration of this type of bone growth. It also shows that bone cells of the original cortex transplanted, even though they are well nourished by being in apposition with living granulation tissue, do not grow, whereas osteoblasts lining the Haversian canals do.

In order to follow these two types of cells carefully, full grown and not young cats were used in these experiments so as to be able to observe the behavior of adult bone cells and not confuse the study with young bone. Consequently the results of this study carry with them the firm conviction that adult, differentiated bone cells are sufficiently specialized, in the same manner that nerve cells are, to be unable to reproduce themselves.

In the oldest transplants practically none of the original bone is left, but its place is taken by this new formed bone. Osteoclasts are also found here and there along the edges of the transplant, and at the periphery of enlarged Haversian canals.

As the Haversian canals enlarge they first form spaces, thinning out the intervening bone into trabeculæ, and later forming larger marrow spaces filled with hæmatopoietic marrow.

The new bone arising from the Haversian canals grows from the edges of the cortex transplant just as vigorously as does that arising from the cambium layer of periosteal transplants, and invades cartilage in the same manner with epiphysial line formation.

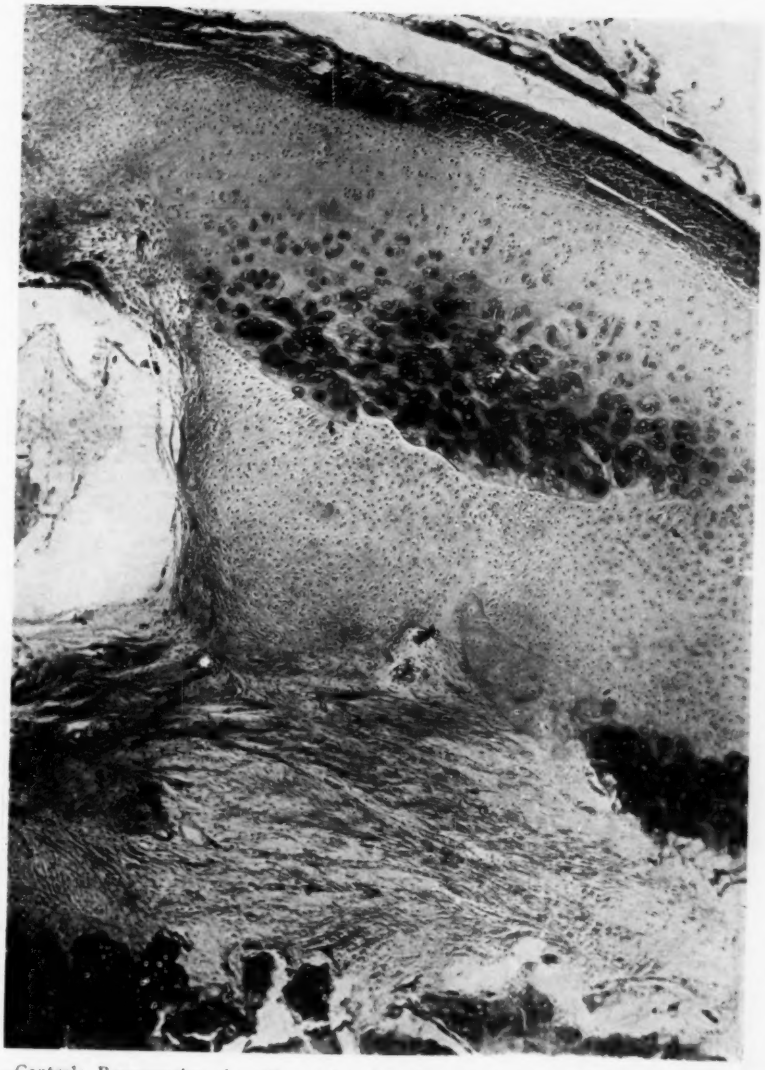

FIG. 1.—Control: Regeneration of cartilage only, after slivers of cartilage were lifted up and tied back again in place (× 60).

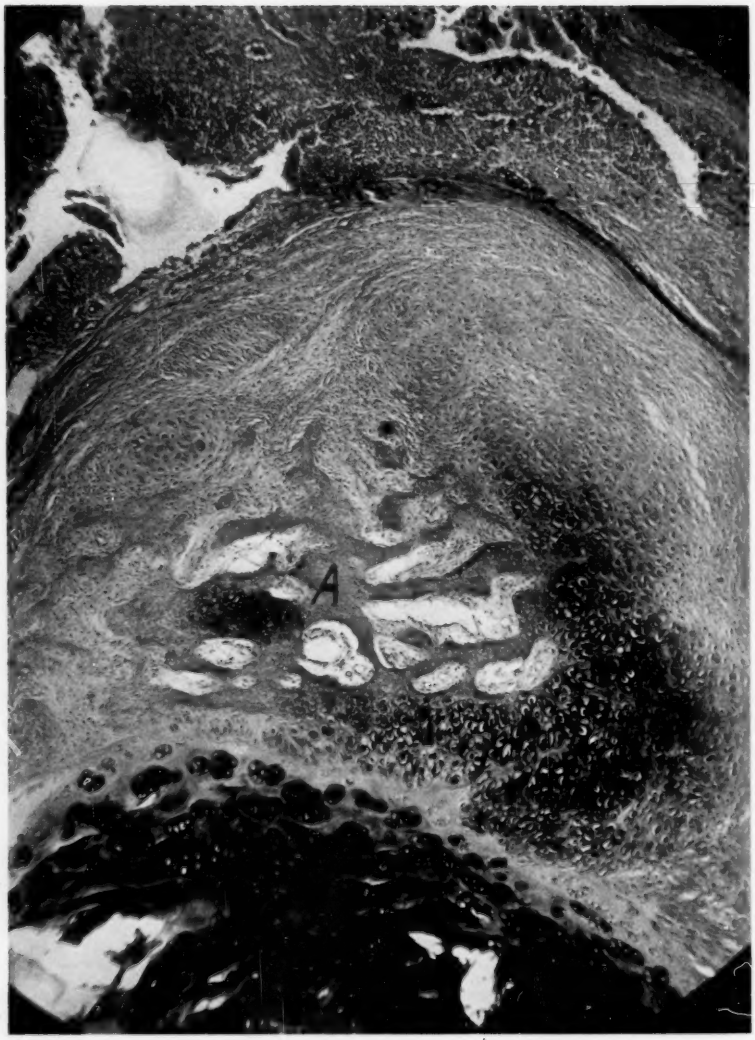

FIG. 2.—26-day transplant of periosteum upon the surface of cartilage denuded of perichondrium; showing the growth of osteoid tissue from the periosteum (A) (× 60).

FIG. 3.—53-day transplant of periosteum upon surface of cartilage denuded of perichondrium; showing growth of young bone from the periosteum (A) (× 60).

FIG. 4.—245-day transplant of periosteum upon surface of cartilage denuded of perichondrium; showing bone (*A*) with epiphyseal line formation (*B*) growing from periosteum (× 40).

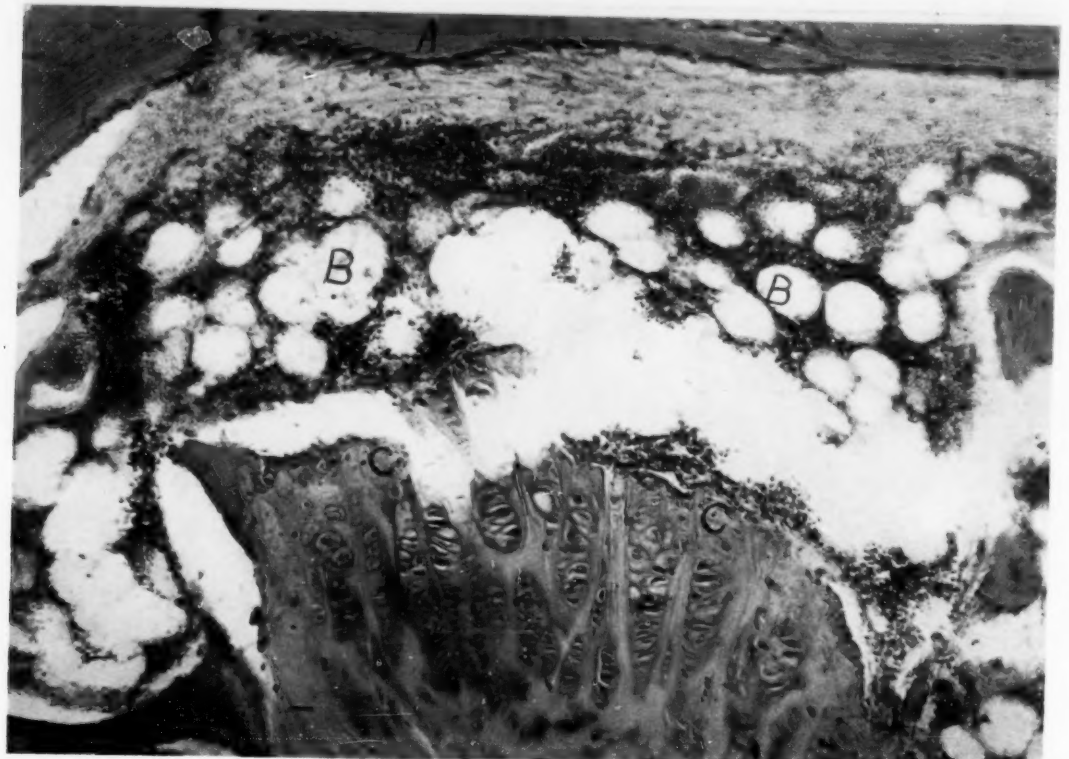

FIG. 5.—High power of Fig. 4. *A*, bone; *B*, marrow; *C*, epiphyseal line formation (× 100).

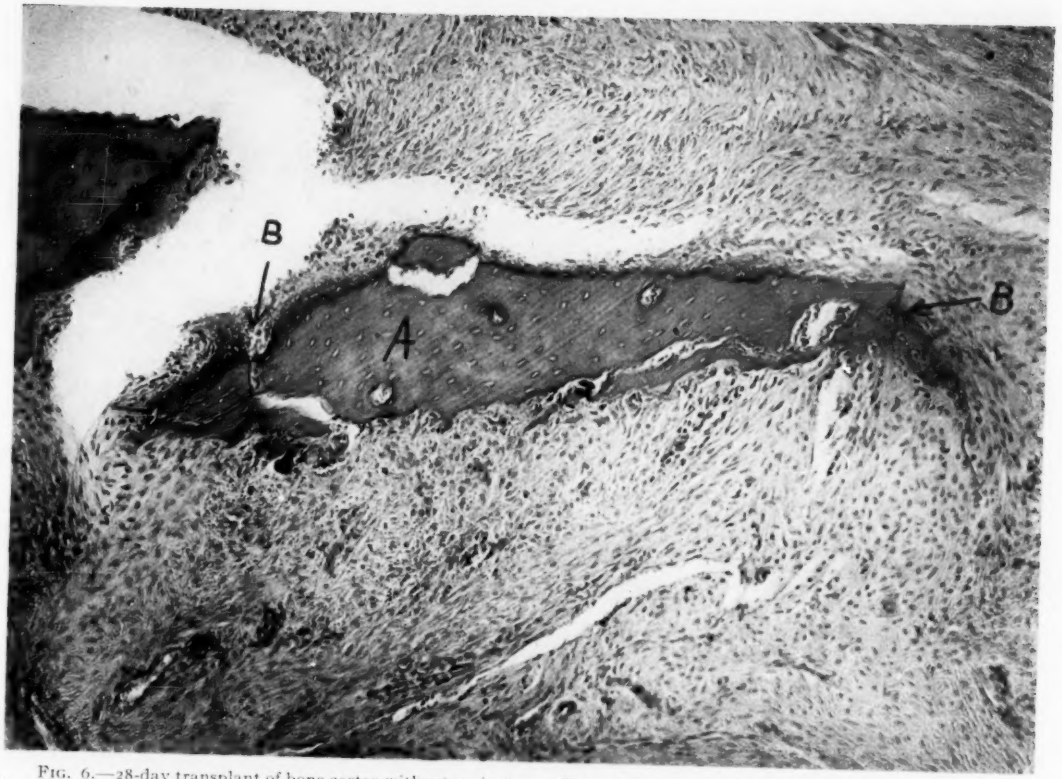

FIG. 6.—28-day transplant of bone cortex without periosteum. Transplant is upon surface of cartilage, but the cartilage is not shown in the photograph. The transplanted bone is dead (*A*) and the lacunar spaces are empty. There is growth of bone around some of the Haversian canals (*B*). (× 60).

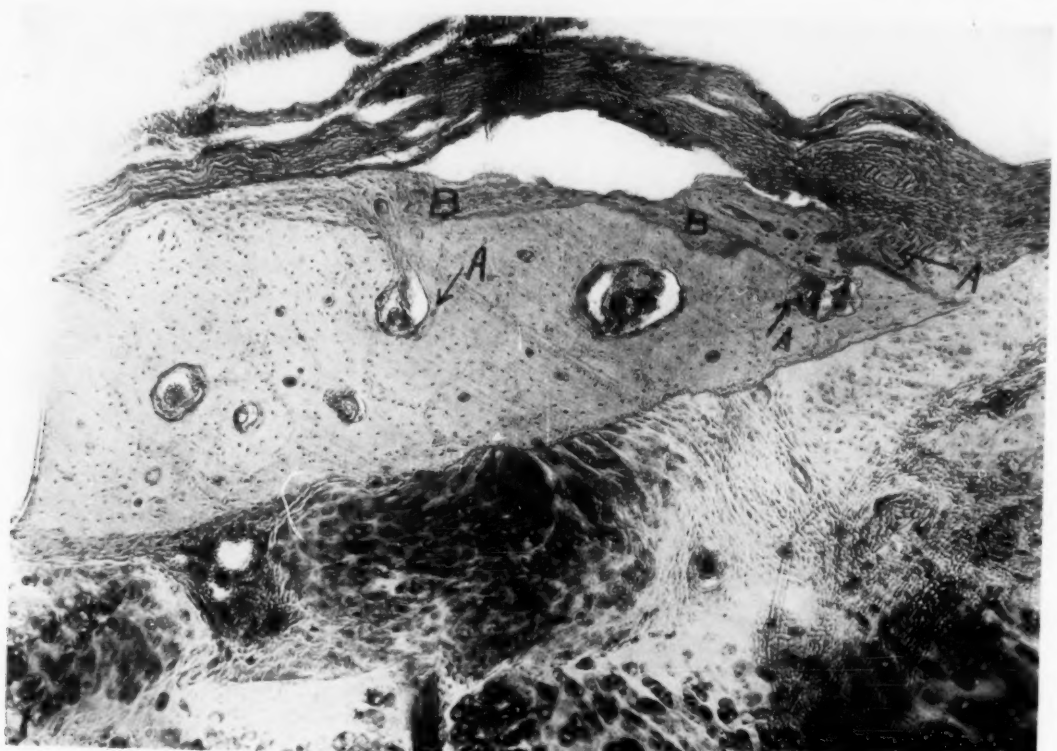

FIG. 7.—245-day transplant of bone cortex without periosteum. Transplant is upon surface of cartilage. There is proliferation of bone from around Haversian canals (*A*) and spreading out upon the surface of the bone transplant (*B*) (× 60).

FIG. 8.—53-day transplant, same as Fig. 7 and showing the same. At *X*, where there is no proliferation of bone, the surface of the transplant of bone is adherent to the surrounding connective tissue just as it is at *B*, where there is proliferation of bone. Consequently, if the growth of bone occurred from adult bone cells the conditions of growth, such as vascular nourishment, are as good at *X* as at *B*. Since growth has not occurred at *X*, this section would indicate that adult bone cells are incapable of growth and proliferation (× 60).

FIG. 9.—High power of same as Fig. 8, showing double nuclei in a young lacunar cell (*A*) (× 200).

FIG. 10.—35-day transplant of cortex plus periosteum upon surface of cartilage denuded of perichondrium. This shows proliferation of bone (*B*) between periosteum (*D*) and an area of dead transplanted bone (*E*). There are present other areas of dead bone and also bone proliferation around Haversian canals (*F*) (× 100).

Those transplants which are covered by periosteum show a growth of bone between it and the cortex which is more advanced than that proceeding from the Haversian canals and so undoubtedly is formed from the intact cambium layer.

Where the transplants are made up of cortex plus cambium, the growth from the Haversian canals, which breaks through on to the surface, is as active as the growth from the cambium layer.

The subcutaneous transplants show this same group of processes. One series of transplants into the spleen shows also the same findings, but another series left for even a longer interval showed less growth of the transplants, but persistence of them. This must be attributed to either a difference in action of similar transplants in different animals, or to a difference in the action of the spleen in different animals.

The few transplants which included endosteum, though not enough to allow any definite conclusions to be formed, showed an even greater growth from the endosteum than from any other transplants, even including periosteum.

It must also be noted that the transplants of cortex plus periosteum retained their vitality longer than those devoid of periosteum and more of their bone cells persisted and less of their bone was absorbed.

To summarize: Especial emphasis must be placed on the activity of the osteoblasts lining the Haversian canals in forming new bone. These cells are always transplanted along with bone and consequently play a considerable rôle in bone formation under these circumstances. This point has been noted by Mayer and Wehner, but its significance and importance has not yet been fully emphasized. Many workers have reported new growth of bone as occurring from freely transplanted pieces of cortical bone. As these pieces have been devoid of periosteum, cambium layer, and endosteum, the new bone production has been considered as arising from the bone cells. Most of these specimens have not been carefully examined microscopically, and consequently the exact source of osteogenesis was not determined.

We believe, therefore, that it has never been shown conclusively that an adult bone cell can divide and produce new bone cells and new bone—and by an adult bone cell is meant a fully developed bone cell within a lacuna formed of completely calcified osseous tissue. The adult bone cell must be carefully differentiated from the osteoblast within a lacuna surrounded by uncalcified matrix. This latter is not a bone cell in the accurate sense of the term, but has frequently been erroneously so called. This young cell is the active one in creeping replacement. Mayer and Wehner indicate that they have also reached this conclusion.

The study of this point in the literature is difficult because of a confusion arising from a loose use of the term bone cell. An instance of this can be noticed in the excellent recent article by Phemister, where he describes bone formation from the osteoblasts lining the Haversian canals

and apparently considers the osteoblasts to be bone cells. Of course, in regenerating bone where replacement of the osseous tissue is occurring by both lacunar absorption and substitution and by creeping replacement, the young bone cells are in apposition with the old cells and differentiation is at times difficult. Still, we believe that this differentiation is possible by careful microscopical study. The identification of periosteum, endosteum, and osteoblasts lining Haversian canals, and the bone which arises from them, is in reality easily accomplished. It has been definitely proved that osteoblasts in all of these locations can produce bone and that those in the Haversian canals can assume considerable osteoproductive activity when they are properly nourished. This accounts for their activity in transplants of small fragments of bone where the revascularization of the Haversian canals takes place rapidly and the lining osteoblasts are kept alive till this occurs by plasma from surrounding tissues. In large transplants more time is required to establish a new source of nourishment for these particular osteoblasts and their osteoproductivity is correspondingly reduced. Nevertheless, in transplants of cortex devoid of periosteum and endosteum these cells are responsible for whatever new intrinsic bone formation takes place. It naturally follows that any factor which aids in the nourishment of these cells also aids bone growth in the transplant. Since the periosteum covering the cortex is of material assistance in this nourishment, it can readily be seen how transplants of cortex covered by intact living periosteum are more probable of success, aside from the osteogenic function of the cambium layer, than are transplants devoid of periosteum.

CONCLUSIONS

1. Periosteum, devoid of adherent bone cells when transplanted into foreign tissues, produces bone.

2. Endosteum and osteoblasts lining Haversian canals in bone transplants produce bone very actively.

3. The cambium layer when adherent to transplanted cortex produces bone.

4. Some bone cells in the transplants are able to persist for almost a year, but most of the bone is absorbed.

5. Fully developed adult bone cells, although they may remain alive for a considerable time, do not reproduce themselves and form bone.

6. Very young lacunar cells (frequently erroneously called bone cells) can reproduce themselves and form bone.

7. Transplanted bone is absorbed not only by osteoclasts, but also by a direct action (biochemical?) of growing, young bone, and the transplanted bone is replaced either by a creeping forward of the new bone or a gradual extension or expansion of the new bone into the transplant.

8. Marrow spaces and hæmatopoietic marrow are formed in the bone which develops from transplanted periosteum. The source of these hæmatopoietic cells was not determined.

9. Bone, when it grows into cartilage, does so in the same manner characteristic of the normal embryonic development of enchondral bone, including also epiphysial line formation.

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TRAUMATIC LUXATION OF THE SACRO-ILIAC SYMPHYSIS WITHOUT FRACTURE OF THE PELVIS

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While J. W. M., age 50, height 5 feet 9½ inches, native of San Francisco, weight 206 pounds, master mechanic at the Western Sugar Refinery, was working at the bottom of an elevator shaft, July 26, 1916, a heavy freight elevator descended. He attempted to escape, but too late; while on hands and knees the elevator came down upon the small of the back and hips, forcing him down on a concrete floor, where he was held fast for a brief interval. He entered the hospital 11.15 A.M., in profound shock, temperature 97, pulse 60, suffering great pain in the pelvis. The left thigh was flexed upon the pelvis, adducted and rotated inward, the leg was flexed upon the thigh. He was unable to void urine normally until 4 P.M. of the next day. Examination by X-ray showed luxation of the head of the left femur upward and backward upon the ilium. In the radiogram a portion of the sacro-iliac symphysis showed and bore evidence of injury to that joint. On account of shock no operative procedure was undertaken until July 27th, when, under anæsthesia, the luxation at the hip-joint was reduced. Attempts at reduction by Bigelow's method failed, probably due to luxation of the innominate bone. The pelvis was firmly fastened to the table and strong traction applied to the limb in full extension, and in a line parallel with the axis of the body, when the head of the femur was felt to slip into the acetabulum. The left lower limb now assumed the position of marked external rotation, with the toes inverted.

Further examination by radiography showed wide separation both at the sacro-iliac symphysis and at the symphysis pubis, indicating upward and outward luxation of the left innominate bone. August 3d this was reduced in the following manner:

Patient was anæsthetized and fastened to a Hawley fracture table; a yarn rope was passed over the crest of the left ilium from before backward, one end being brought down behind the body and the other in front. To this two guy lines were fastened, one carried behind the pelvis and the other in front and held at right angles to the axis of the body, by an assistant. They were to prevent the yarn rope from slipping over the iliac crest during traction. Steady and continuous traction was then applied to the crest of the ilium by means of the yarn rope. When it was thought that the bone had been restored to its normal position a radiogram was taken, while traction was still in force, which showed reduction complete. A transverse incision was next made over the symphysis pubis and both pubic bones drilled; a wire was then passed through and tightened while the bones were being approximated by external pressure. A broad band of adhesive plaster was then passed snugly about the pelvis and a plaster-of-Paris cast applied,

including both thighs to the knees and extending upward as high as the axillæ. Later examination by X-ray showed that some upward and lateral displacement still persisted. This was overcome by cutting a window in the front of the cast, over the pelvis, and inserting through it, between the pelvis and the cast, a heavy piece of sadler's felt on each side. A strong muslin bandage was then passed around outside the cast and loosely knotted. Through a loop in this the end of a rod two feet long was passed and tightened by twisting after the manner of a Spanish windlass. When sufficiently snug the rod was held in place by adhesive plaster. Next a weight of 22 pounds was fastened to the leg and passed over a pulley at the foot of the bed. With this X-ray showed the deformity corrected. The cast and weight were removed September 23d, and the patient left the hospital October 1st.

He returned to work June 4, 1917, after a period of disability of ten months and eight days. Recovery was in every way complete, with no shortening of the limb nor loss of function.

REMARKS.—Much confusion regarding this injury prevails in the profession. Says Eisendrath[1]: "A diastasis or dislocation at one of the symphyses is extremely rare, and it is impossible to recognize it during life." According to Stimson[2]: "Pure separations at these points (the symphyses) without fracture are rare, and except at the symphysis pubis, hardly to be diagnosticated during life." Malgaigne gave a classification of luxations of the pelvic joints, but failed to differentiate simple luxations from luxations complicated with fracture, and his classification has generally been discarded.

Hitherto a comprehensive search of the literature of this lesion seems not to have been made; consequently we may be pardoned for having attempted one. The search has resulted in the discovery of only eleven fairly well authenticated cases. Cases of subluxation and luxation complicated with fractures of the pelvic bones and so-called sacro-iliac relaxation, sacro-iliac slip, etc., also pathological luxations and the condition arising in the pregnant state have been excluded.

The luxation, in the frequently quoted case of PHILIP,[3] reported in 1763, was probably pathological, since the diagnosis was not made during life and at autopsy a large amount of pus was found in the sacro-iliac joint.

According to SALLERON, the first case of sacro-iliac luxation to be observed and placed upon record was that of Enaux[4] which occurred in 1784. In this case the left innominate bone was luxated upward and backward. The diagnosis was confirmed by Hoin and Chaussier. Attempts at reduction in this case failed, but it is stated that after being put on crutches the weight of the limb effected reduction.

In the case of THOMASIN,[5] 1785, no doubt sacro-iliac dislocation was present, but sufficient care was not exercised in observing and reporting the case to exclude the presence of fracture as well.

In the case of BAKER[6] reported in 1830 autopsy showed sacro-iliac luxation, but there was also present a small fracture of the ilium.

The case of TRACHEZ[7]: A military officer, 38 years of age, of good constitution, and above medium height, fell from the third story to the street pavement, March 15, 1837. He alighted upon the two ischial tuberosities, in such a way that the two

innominate bones were carried upward and the sacrum forced downward. Great pain and tenderness about both sacro-iliac symphyses followed. The iliac crests were elevated on a level with the false ribs, and there was present paralysis of both lower limbs, bladder and rectum. No attempt was made to reduce the luxations and they became permanent. The paralysis improved only partially, so that when seen nearly ten years later his recovery was very imperfect. His height was reduced in proportion to the relative elevation of the innominate bones.

The case of THUVENET,[6] 1849: A man of 27 years of age, of athletic build, while working at a quarry, a cave-in of earth fell upon his back, throwing him violently to the ground upon his abdomen.

Two hours later he entered the hospital in a very grave condition. Swelling and ecchymosis covered the anterior inferior abdominal wall, inguinal regions, scrotum and perineum. Catheter inserted into the bladder drew off only a small amount of blood. He died 44 hours after entering the hospital, before any diagnosis of injury to the skeleton had been made. Autopsy revealed extensive infiltration of the pelvis, abdominal wall and subperitoneal tissue with blood. There was an irregular laceration of the anterior wall of the bladder three centimetres long. The symphysis pubis was disrupted and the bones separated the distance of two fingers' breadth. The left sacro-iliac symphysis was completely destroyed; that of the right almost so. The sacrum was easily detached.

The case of PARMENTIER,[7] 1850: A heavy oaken door fell upon a man passing, threw him to the ground upon his back, crushing the entire body, the head only escaping. Separation of the symphysis pubis was immediately recognized on his admission to the hospital. The right was elevated above the left; the abdominal wall and perineum were contused and infiltrated with blood. Patient died 24 hours after the accident. At autopsy blood was found in the peritoneal cavity. The right pubis was found elevated three centimetres above the left. All of the ligaments of the right sacro-iliac symphysis were torn through. The ilio-lumbar and the sacro-sciatic ligaments were likewise torn through. On the left side the sacro-sciatic ligament and the anterior sacro-iliac ligament were torn, but the interosseous ligaments, ilio-lumbar and the posterior sacro-sciatics were sound.

Case of FLEMING,[8] 1855: While a stout youth, aged 19, was in the act of leaping from a cart in motion, his feet became entangled in a rope, and he fell to the ground, alighting on his face, and while in this position the wheel of the cart passed obliquely across his pelvis. The cart and its load weighed nearly two tons. On admission to the infirmary, a few hours after the accident, the left ilium was found to project about an inch further behind the sacrum, and its crest was fully an inch and a half higher than on the right side. Hip was elongated and swollen, but depression at the joint and projection at trochanter were quite distinct. Motions of hip, knee, and ankle joints were free and unattended with any marked pain. Limb was shortened by fully an inch. He complained of pain at lower part of abdomen, and was unable to void urine, requiring the use of the catheter.

When dismissed the limb was shortened about three-quarters of an inch, the left ilium appeared as much higher than its fellow, and projected slightly more behind the sacrum.

In 1871 SALLERON[9] published a notable memoir upon traumatic luxations of the pelvis, in which he reported three cases which came under his own observation, and reviewed the literature in some others. His cases occurred in connection with his service with the French army in northern Africa.

OBSERVATION I.—B. C., aged 26, native of Sardinia, master mason, healthy man of good constitution, but of slender build, August 29, 1849, fell to the bottom of a well 12 metres in depth, the fall being unbroken by any obstacle. He alighted upon the buttocks, all of the weight of his body being transmitted to his left buttock, which struck upon a slight ridge. He retained consciousness and soon experienced

a desire to urinate without being able to accomplish the act. When he arrived at the hospital, diagnosis of forward and upward luxation of the second part of the sternum upon the first was readily made, also luxation upward and backward of the left ilium upon the sacrum. The left anterior superior spine was strongly depressed and sunken into the abdominal wall. The anterior superior spine and crest of the left ilium were elevated 15 to 18 millimetres above corresponding parts of the right. The left posterior superior spine made a very noticeable prominence. The left leg was extended parallel with its fellow, toes slightly everted. Measurement from the anterior superior spine to the tip of the malleolus showed no shortening, though the left knee was on a higher plane than the right.

The manner of reduction was interesting, but the description is too long for insertion here. He was discharged 47 days after the accident.

Observation II.—A. D., age 36, Zouave of medium height and good constitution, while intoxicated fell from the second story window of his barracks and struck the posterior part of the right side of the pelvis upon very hard and uneven ground. Examination showed marked prominence of the entire right iliac region. The right anterior superior spine of the ilium was elevated 10 to 12 millimetres above the left and on a plane anterior to it. The iliac crest obviously approached the false ribs. The right pubic spine formed a marked prominence, was elevated above and on a plane anterior to the left; movement of the right hip-joint was free and painless. Spontaneous reduction occurred on turning the patient on his left side and he left the hospital 46 days after his injury and recovery was complete at the end of three months.

Observation III.—M. J., Spaniard, age 38, excavator, was thrown down upon the anterior surface of the body by a slide of lime stones, which fell from a height of four or five metres, and covered him almost completely. He experienced severe pain in the pelvis, and diagnosis of forward luxation of the ilium upon the sacrum was made upon the following indications: The left hip formed a very marked prominence forward and outward; the anterior superior iliac spine projected forward and upon a plane anterior to the right; the left iliac crest was more elevated than the right; the left posterior superior spine was completely effaced and marked tenderness to pressure over its site was noted. Tenderness was very marked at the site of exit of the sciatic nerve from the pelvis and at the symphysis pubis. Spontaneous reduction occurred on the fifth day. The injury was followed by atrophy of the left lower limb, supposed to be due to nerve injury at time of accident. He was discharged 86 days after injury.

Case of J. Thornsby Jones*: H. J., age 55, powerfully built, was admitted to St. Bartholomew's Hospital, January 17, 1878, having been knocked down by a traction engine an hour before admission. The urine was passed voluntarily and was free from blood. He died seven hours after admission.

Necropsy.—The intestines and all of the organs, both abdominal and thoracic, were in a healthy condition and none were injured. After removing the small intestines, an extravasation of blood was found occupying the rectovesical pouch and the loose tissues around; and on dissecting through this, the iliolumbar artery on the right side was seen to be wounded. The veins on this side were unhurt; but on the left side, the external iliac vein was wounded at a point opposite the sacro-iliac articulation. On removing the rectum, bladder, the vessels, and the loose tissue from the pelvis, it was at once seen that the sacrum was unusually prominent; and further examination showed that it was separated from its articulation with the ilium on each side. The anterior sacro-iliac ligament was ruptured, all but a few fibres. The anterior border of the articulating surface of the sacrum was at least a quarter of an inch in front of that of the ilium on both sides. The posterior aspect of the articulation was then examined, and here the ligaments could not be well defined on account of laceration of the gluteus maximus and the extravasated blood. A careful

examination was then made of the whole pelvis and at no point was a fracture found.

Case of WILHELM,[10] 1899: Man aged 46, upon whom an elevator, which with its load weighed 2000 kilograms, descended, pressing downward upon his back. It held him in that position for 20 minutes. He entered the hospital in profound coma; pulse 140 and thready. The catheter drew off urine at first clear, later faintly sanguineous. The two iliac crests formed two enormous posterior prominences; the posterior part of the left iliac crest in particular nearly touched the lower border of the ribs. He left the hospital two months later, walking with two canes; his attitude was inclined to the left with notable forward flexion of the body. The ilio-sacral troughs were very deep, particularly the left. In walking the patient executed a movement of balancing the trunk similar to that of a patient with double congenital dislocation of the hips. He had lost 6 centimetres in height and there remained certain nervous disturbances in the lower extremities. The forward luxation of the sacrum, without separation of the pubes, remained.

Case of HOPKINS,[11]: H. F., aged 18 years, was admitted to the Pennsylvania Hospital December 23, 1898, having been caught in an elevator. On admission he gave evidence of considerable shock. The left limb was shortened and the foot everted. Examination of the hip showed it to be unhurt. The left ilium was found to overlap the sacrum, so much so that the tips of the fingers could be insinuated beneath it, as they can beneath a scapula. Exploration was made for the other point, which had yielded to allow of this break in the pelvic ring, and it was found at the symphysis pubis. The joint was quite mobile, this being easily discernible by pressure upon the anterior processes of the ilium. A deep right-angled contusion of the integument over the left side of the sacrum testified to the violence of the forward pressure. There was no paralysis, nor was there evidence of concealed hemorrhage of any severity. Reduction in this case was not quite complete; however, it is stated that patient made a good recovery.

In closing, the author states: "While not attempting, therefore, to have exhausted the literature of this very rare and interesting injury, I venture the opinion that it is the first case recorded of complete sacro-iliac dislocation occurring in a sound pelvis to recover after reduction." This opinion is controverted by the cases that have been collected in this paper.

The case of BRAQUEHAYE,[12] Adda, and Bruch, 1913: Cameille W., female, age 21 months, born at term and in good health. The nature of the traumatism in this case was not determined. She was supposed to have fallen from the top of a table or from a nurse's arms. A correct diagnosis was not made until 31 days after the injury, when radiography showed wide separation of the right sacro-iliac symphysis. Five days later the luxation was reduced, with the patient under chloroform. The operation was guided by the fluoroscope. The right lower limb was placed in a plaster-of-Paris cast, in extension and forcible abduction. This was maintained for more than three months, and eight months later patient was perfectly cured, walking without a limp. DELBEAU [13] reported a case of luxation of all the joints of the pelvis, which, however, was complicated with a very small fracture of the right ilium.

Diagnosis with the aid of X-ray is easy, without it difficult and uncertain. Certain changes in anatomical form are observed in the region of one or both innominate bones. There is shortening of the limb on the affected side when measured from the umbilicus, and no shortening when measured from the anterior superior spine. When the innominate bone is released from its attachment to the sacrum and to its fellow at the symphysis pubis, the powerful muscles attached to it from above draw it upward. There is generally external rotation of the limb with the toes in eversion, due to change in relative position of the cotyloid cavity. Some

authors emphasize the importance of digital exploration by the rectum. It is needless to say that all serious injuries about the pelvis should be subjected to X-ray examination.

The prognosis is grave; the injury is nearly always followed by severe shock. In the 12 cases reviewed above, including my own, there were three deaths, a mortality of 25 per cent. Death is not due to injury to the skeleton, but the great violence necessary to produce this lesion expends itself upon the blood-vessels and viscera; of the viscera the bladder is the one most often wounded. In nearly all cases inability to void urine was recorded. In one case both limbs were partially paralyzed which condition became permanent. In another the leg on the affected side atrophied. In one case the stature was shortened by 6 centimetres. In one other there was shortening of stature, amount not noted. In five of the cases disjunction at the symphysis pubis was noted. In two cases the result was recorded as perfect. In both the diagnosis and treatment were conducted under the guidance of radiography. Three of the cases were due to elevator accidents.

When the luxation is complicated with fracture of the pelvic bones, Salleron believed that the luxation occurs first and the fracture results from the continued action of the luxating force.

The treatment has already been sufficiently described.

From the facts which we have presented it is clearly evident that simple luxation, caused by external violence, of the sacro-iliac symphysis with or without separation at the symphysis pubis, though very rare, is entitled to a place among well recognized traumatic lesions.

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FIBROCYSTIC AND CYSTIC LESIONS IN BONE

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The fibrocystic and cystic degenerations found in the benign and malignant neoplasms are not included in this paper. Only those lesions in bone that conform to our modern conception of inflammation and its allied processes are here considered. We must, of course, bear in mind that these fibrocystic changes are always secondary and chronic.

A careful study and survey of the literature covering the subject of fibrocystic and cystic lesions in bone reveals very clearly that there exists a great diversity of opinion among men interested in bone surgery in their expressed views regarding the etiology of these diseases. One also gathers from a perusal of the literature that the methods of reaching correct diagnoses are sometimes far from exact. The most common sources of error seem to be caused in mistaking a generalized or systemic pathologic process for a purely localized condition. Another source of error is in calling a lesion "bone cyst," from the appearance of the radiographic picture, alone. It must be borne in mind that a localized spot or area of osteolysis, that the X-ray plate reveals, is not necessarily a bone cyst. Elmslie's elaborate paper covers the consensus of opinion held up to 1914.

Accumulated experience gained in the surgery of pathologic bone processes confirms the writer in the belief that a simple regrouping of these lesions is desirable at this time, particularly in view of the fact (thanks to the illuminating data obtained by the Röntgen ray) we now know they are not uncommon. A simple division of the non-neoplastic lesions into two separate groups has distinct advantage because it enables us, in a clear, concise and comprehensive manner, to include practically all the pathologic processes coming under these headings. Group 1 should include all multiple fibrocystic and cystic lesions, *i.e.*, multiple lesions in a single bone, single lesions in numerous bones and multiple lesions in several bones. All diseased processes covered by this group may be considered as being due to some general systemic disturbance. Group 2 includes all the solitary fibrocystic lesions that conform to our modern conception of a non-neoplastic state. These single bone pathologic processes cover, by far, the greatest number of the affections in bone that are fibrocystic in character. They embrace the most important group from the standpoint of the surgeon. The large majority of them are amenable to surgical intervention and cure. Some of the solitary lesions that present in a single bone are undoubtedly due to pathologic change, general in character. These and their diagnoses will be discussed with the solitary lesions.

Etiology.—The main etiologic factors causing the multiple lesions in

Group 1 are: (*a*) metabolic, (*b*) syphilis, (*c*) tuberculosis, (*d*) other bacterial infections, (*e*) parasites, (*f*) hæmophilia.

In the second group, localized trauma is the apparent factor in 75 per cent. of cases, the remainder of the solitary lesions come under the factors cited in the first group.

Group 1.—(*a*) *Metabolic Processes.*—Faulty bone metabolism is quite generally believed to be due to an interference with endocrinal glandular equilibrium. Recent investigations seem to show that the parathyroids play a rôle in calcium content control. Experimental work done by McCrudden has been most interesting in showing that improper nutritive balance is a factor in faulty bone metabolism. He found that feeding with foods lacking in calcium salts never decreased the calcium output, and that, after a period of such dietary, bone softening occurred. We must regard this process of softening as one of the steps aiding in the later formation of general multiple fibrocystic and cystic lesions in bone. Von Recklinghausen's work (published in 1910, under the title "Rickets and Osteomalacia") covers the subject of these general systemic metabolic bone changes in all their phases. He has grouped them under the term "malacia," *i.e.*, myeloplastic, phlegmatoplastic, metaplastic, etc. Metaplastic malacia is, perhaps, of most interest to the surgeon because it embraces, first, the fibro and fibrocystic type of lesion commonly termed "osteitis fibrosa," and, second, the hyperplastic form usually described as "osteitis deformans or Paget's disease." The fibrocystic stage of the lesion is always deficient in lime salts. The hyperplastic solid phase (osteitis deformans) has been shown by DaCosta and others to exhibit areas of lime salt content in greater amount than normal, as well as an increase of the so-called osteoid tissue. In the writer's opinion, both so-called osteitis fibrosa and osteitis deformans have their genesis in the main, in an excessive hyperplasia of soft fibrous structure, whose origin is the reticulum of the bone marrow. During the formation of this soft fibrous hyperplastic tissue, there apparently is produced a partial or complete obliteration of many of the small vessels, thereby causing inhibition of bone nutrition with resultant halisteresis or absorption. This tissue, at the stage of cystic formation, seems to have no affinity for lime salts. Whereas, the solid lesion or lesions we term "Paget's disease of bone" exhibits not only dense fibrillation but also, according to recent investigation, presents an increased lime salt content. This stage of the metaplastic process is believed by some observers to be a reconstructive effort.

Hirschberg, who described the fibrocystic lesion in 1889 as osteomalacia with cyst formation, came nearer the mark than von Recklinghausen, who, in 1891, gave it the title "osteitis fibrosa." One gathers from the latter's work (published in 1910) his recognition of the accuracy of Hirschberg's definition, because in that publication he classifies the lesion under the heading "metaplastic malacia." Berard and Alamartine (in their paper published August to November, 1915) do not feel the term "osteitis fibrosa" properly describes these osteodystrophic fibrocystic processes in bone. They consider the lesion or lesions a diffuse process and give their pathologic findings:

"The gross pathologic picture sometimes shows areas of brown or reddish-like masses composed of bony and medullary tissue, which, under the microscope, looks like myeloplax sarcoma. Cystic areas are sometimes seen containing only serous or sanguinous fluid. The soft fibrous structure is slightly vascular; this tissue, poorly nourished, gradually increases in softness and little by little gives birth to multiple cysts." They also express the view that these osteodystrophic lesions are not uncommon in old people. The writer is able to confirm this observation.

The observations of Berard and Alamartine regarding a mixed pathologic picture is in full accord with the earlier views expressed by Hirschberg, Rehn, von Recklinghausen, Bloodgood and others. None of the observers have explained or apparently considered the giant-cell content, with the exception of Bloodgood, who states:

"Although giant-cell tumors are found in many bones, in not a single instance has metastasis to internal organs been found."

It does not seem to have occurred to these observers that the so-called giant-cell sarcoma areas within these generalized fibrocystic processes were, in fact, an exhibition of an active localized and local regenerative effort and that the presence of the granulation tissue mass was the best possible evidence of an attempt at repair and restoration. The same may be stated of the giant-cells found in these lesions; their presence has always been noted in structure containing inert absorbable sterile substances. It has never been demonstrated that the giant-cells, accompanying granulation tissue proliferation in structural defects, had other function than that of scavenger, or that such cells have anything whatever to do with neoplastic growth. The microscopic picture of fibrosis found in these lesions simulates, in a marked degree, the fibrosis of a chronic cystic mastitis.

(*b*) *Syphilis.*—The inherited or congenital form of syphilis not infrequently exhibits localized areas of disease in the cancelli, particularly of the long bones, that are fibrocystic or cystic in character. The lesions may be limited to a single or occupy several bones. They are less frequently seen in acquired syphilis. They are primarily due to infiltration of gummatous foci, which has produced bone destruction. The products of the gummatous mass have become absorbed and the fibrocystic or cystic lesion is left as an end-result. The bones presenting these lesions may not give any of the usual pictures suggestive of syphilis, such as general thickening of the cortex, periosteal inflammation, bowing, or irregularity of the peripheral lines. Indeed, where only a solitary lesion exists in the cancelli, one must often remain in doubt as to its true etiology, even with all the criteria of syphilis present.

(*c*) *Tuberculosis.*—Rarely causes multiple fibrocystic or cystic lesions in bone.

(*d*) *Other Bacterial Infections.*—In their chronic phases sometimes present localized areas of osteolysis near joints that are found at operation to be fibrocystic or purely cystic in character.

(*e*) *Parasitic Cysts.*—The writer has observed only one case in a series

of thousands of bone lesions. The infecting parasite proved to be an echinococcus found in the upper end of the femur.

(*f*) *Hæmophilia.*—A lesion, presenting under the X-ray a localized area of osteolysis in the upper end of the tibia, has been observed in a very much enlarged hæmophilic knee.

GROUP 2.—Includes the solitary fibrocystic and cystic lesions in bone that arise independent of degenerative cystic changes in benign or malignant neoplasms. These solitary pathologic processes in bone cover, by far, the greatest number of the affections that are fibrocystic or purely cystic in character. It should be emphasized that the lesions are never primary; always chronic and usually inactive. The apparent etiologic factor in about 75 per cent. of the solitary processes is bone trauma, due to direct injury, dating back months or years. In every instance of immediate injury, or destruction of portions of the cancelli in normal bone, the later fibrocystic changes are preceded by primary effort at repair in the formation of granulation tissue. The metaplasia or conversion of the granulations into fibrous structure really exhibits failure of the effort at complete anatomical and physiological restoration. It represents partial cure and is an end-result. The same efforts at reconstruction take place in localized lesions that are brought about by the hæmatogenous bacterial infections, by syphilis and by tuberculosis.

Solitary lesions frankly cystic are not uncommon; they may be caused by any of the above-mentioned etiologic factors. They are usually entirely free of detritus, granulations, or fibrous structure, containing, at times, clear straw or sanguineous fluid. The cavity is cemented by a wall of osteofibrosis, or by a dense, bony shell ranging from 1 to 5 mm. in thickness. When a lining membrane intervenes, the bony or osteofibrous wall is usually absent.

The cysts found in so-called medullary giant-cell sarcoma (hemorrhagic osteomyelitis) should be grouped with the fibrocystic inflammatory lesions of bone. We cannot agree with those who regard these cystic processes as degenerative, any more than we can regard the granulation tissue content in such lesions as neoplastic. The fibrous metaplasia of the granulation tissue produces contraction and retraction of structure, leaving cystic areas. The same process of repair that falls short of complete restoration may be observed in many inflammatory bone lesions. The disease should be regarded as local. The rôle the giant-cells play in this inflammatory bone affection has been published in detail (see ANNALS OF SURGERY, February, 1917).

Single fibrocystic lesions, due to the general systemic disease "metaplastic malacia" of von Recklinghausen, or "osteodystrophy" of Mikulicz, give an entirely separate picture compared with those local lesions due to trauma or to the isolated pathologic processes caused by infection. The former, in so far as our present knowledge obtains, is metabolic.

The disease is well described by Berard and Alamartine as: "A diffuse, fibrous or fibrocystic process, composed of tissue poorly nourished and soft; increased softening gives rise to multiple cysts."

The condition is a progressive one. On the other hand, the pathologic picture we obtain of the tissues in localized lesions, due to trauma, are very different. In the traumatic lesions, the fibrous structure is quite firm, dense and avascular when fully organized. Here the lesion represents the terminal stage of a primary process that had its beginning or origin in a localized hemorrhagic osteomyelitis, which, in its turn, had been preceded by direct mechanical injury, or by the spirochætæ, the tubercle bacillus, or some other infecting organism. In these cases, further bone or tissue destruction, or increase in size of the lesion, does not occur.

Clinical Picture.—The clinical picture obtained from the history and examination in the solitary secondary processes is never striking and is sometimes negative. The lesions are more frequently observed in the first two decades of life. In a majority of instances a careful questioning will elicit from the patient the recollection that months or years before a blow, fall, injury, or contusion had occurred at the site occupied by the lesion. Constant pain is never present; sometimes there is noticeable localized enlargement surrounding the lesion. If the disease is near a joint, there is usually some limitation of motion; tenderness upon pressure is always present. In the lower extremity, a slight limp is rather a constant accompaniment. In some instances, it is quite true that the first intimation of the presence of a fibrocystic or cystic lesion in bone is brought to our attention by a pathologic fracture. We are not justified, however, in assuming from a röntgenogram, that shows an area of osteolysis at the site of the fracture, that the lesion is either solid, fibrocystic or a bone cyst. Single lesions giving no history of bone trauma may be regarded as being due to one of the acute infective organisms, to syphilis, tuberculosis, or to one of the malacias, *i.e.*, myeloplastic or metaplastic.

Multiple lesions, when due to the malacias, in so far as one may gather from the literature and from observation of cases of my own, are not ordinarily productive of pain; the individuals come for treatment of some deformity or fracture. One patient, who has been under observation for six years, shows X-ray fibrocystic lesions in his pelvis, femoræ, tibiæ and fibulæ (all bones above the pelvis are normal). He has never had any illness, never any pain, numerous blood pictures have been normal, urinary examinations always negative, no Bence-Jones' bodies. He looks physically well. First came for treatment of deformity following fracture of femur. In all cases where we suspect pathologic fracture, our routine practice is to have the entire skeleton röntgenographed; the value of such a procedure was graphically shown in this case.

Diagnosis.—A careful interpretation of the clinical facts taken in conjunction with the gross pathology the röntgenogram reveals in these lesions enables one to make a presumptive diagnosis. No pre-operative method or study compares in value or importance to the information given by the X-ray in permitting a decision regarding the presence or absence of an area or areas of osteolysis. Its value is negative, however, in deciding whether the lesion is a solid focus of organizing or organized soft tissue, pus, or fluid, or

of indicating the presence or absence of a lining membrane, or membraneous septa.

The statements frequently made that a localized bone abscess, without bony sequestra, may always be diagnosed from the röntgenographic picture does not hold good; the dense, bony wall or ring sometimes shown immediately surrounding a bone focus may enclose solid soft tissue or fluid without evidence of pus; on the other hand, lesions presenting no dense, surrounding bony wall may contain pus, fluid or soft tissues. It is, in fact, practically impossible to differentiate the type of solitary lesion from any set of röntgenograms taken during any one seance, *i.e.*, between a localized hemorrhagic osteomyelitis, a simple cyst, a sterile abscess without sequestrum or a fibrocystic process. If a series of pictures are taken at intervals extending over a period of time, a more exact X-ray diagnosis is probable.

The writer has been able to make the differential diagnoses from röntgenographic studies, where the opportunity has presented, and for the time being operation has been refused, and offers the method as a new diagnostic measure. For this purpose it is essential to take numerous X-rays extending over weeks and perhaps months. In the first place we know that the localized lesion hemorrhagic osteomyelitis and the solitary fibrocystic lesion due to metaplastic osteomalacia, both slowly increase in size and to this extent both lesions are alike. The differential diagnosis between these two processes is that in the X-ray the former gives a more clearly defined picture, greater regularity of outline and is more nearly circular or oval in shape, dependent upon its location in cancellous structure. The fibrous or fibrocystic metaplastic lesion is less clear cut, its edges have more the appearance of fading away where it is not controlled by periosteum; it is never circular and rarely clearly oval in shape.

In the second place the fibrocystic and cystic lesions, whose origin is not metaplastic, nor due to parasites, do not increase in size. They are an end-result of the process of repair. Chronic sterile bone abscesses, without sequestra, also remain stationary; a differential diagnosis with the X-ray is difficult or impossible. As all these lesions are surgical, confirmatory diagnosis may be obtained at operation.

A diagnosis of the multiple fibrocystic lesions in bone is best made by correlating the clinical with the X-ray findings. They are generalized processes and may be regarded as being due to disturbances producing the malacias, or to syphilis. Multiple fibrocystic processes due to other infections are rare.

Treatment.—Treatment of the solitary lesion resolves itself into the method of surgical procedure.

As bone is perhaps the most sensitive structure in its response to infection, very careful operative technic is essential. The operation is usually simple and minor. Following thorough curetting, the cavity should be swabbed with tincture of iodine, especially for its irritant stimulating regenerative effect. The writer advises against the use of carbolic acid, zinc, or other destroying chemicals followed by the use of alcohol, now com-

monly used for swabbing cavities following curettement in bone. The destructive effect of the acid or zinc is certainly not conducive to granulation tissue proliferation, nor can it aid in the final production of bone to obliterate the cavity. Silver's very instructive case, which at secondary operation showed a dense membrane lining the cavity of a lesion removed a year before, was partially, if not wholly, brought about in the writer's opinion by cementing the walls at the primary operation with carbolic acid and alcohol and perhaps aided to some extent by the plug of tissue left in the cavity. Thorough curetting, removing all obstacles to the outcropping of normal granulations, is the first essential for the final formation of bone and obliteration of the cavity.

Tincture of iodine is not used for its destructive effect—it seems to have none—but for stimulating the formation of healthy granulations. All cavities larger than a pigeon's egg are aided in shortening the process of repair and cure by filling with bone shavings which may readily be taken from portions of the bone above or below the lesion. Whether or not osteogenesis takes place in the shavings, they at least act as a scaffold in supporting the blood clot filling the cavity, the blood clot, in turn, acts as a prop or framework in supporting the out-cropping granulation tissue buds and fibrils which in its last phase will become bone.

The use of the "plombierung" of Moosetig-Moorhof has the following disadvantages over the above simple method of filling bone cavities: *First,* the cavity must be absolutely dry. *Second,* the preparation must be in exact proportion as to ingredients. *Third,* it must be poured into the cavity at a certain temperature difficult to maintain, otherwise the mass shrinks at its periphery and is not in absolute contact with bone, a condition, according to Moosetig-Moorhof, fatal to success, and finally the iodoform content of the plug is in some cases intoxicant to the patient.

The objection to Beck's bismuth paste is that it does not always absorb. The same objection holds for the "agar-agar" jelly of Mikulicz.

Very large lesions that exhibit excessive vascularity, following a thorough curetting, may be tightly packed for a few days before closing, otherwise all wounds should be immediately closed without drainage.

The clinical pictures and röntgenograms of a few illustrated cases selected from the wealth of material at our disposal in the New York Hospital for Ruptured and Crippled, are appended:

CASE I.—*Metaplastic osteomalacia-mixed hyperplastic and fibrocystic types.*

Raymond C., male, white, unmarried, aged thirty-two years. Mother died during his infancy. No brothers or sisters. Can tell nothing about father. Has no knowledge of any diseases of childhood excepting that he was sickly. In 1896, when he was ten years old, was taken to the Presbyterian Hospital for trouble with left hip, said to be tuberculosis. Remembers the leg was put up in extension; he left the hospital several weeks later wearing a brace and high shoe. Thinks he wore the brace and shoe for several months. In 1900 had

attack of severe pain in the left leg and hip. Was sent to St. Mark's Hospital, where he remained for one month. During his stay in St. Mark's the peculiar shape of his legs and the lumps in buttocks and thigh were first noticed. Remained well until 1905, when he ran a nail in his right foot. Three days following this accident infection of the foot and leg set in and lasted for four weeks. This was followed by contractures of knee and foot. He entered Bellevue Hospital later in the year for treatment of the contractures. He states that he was put up for five or six weeks in extension, with good results, when he left the hospital, but was compelled to return again in two weeks time, because severe pain in knees and hips had returned. This time he remained for five months, when he was discharged, "cured." In December of 1905 he entered Bellevue for treatment of d. w. f. On this occasion the masses were noticed in his thigh and specimen removed for diagnosis. The report returned from the Loomis Laboratory was "sarcoma." Was advised to have the masses removed for the purpose of making a toxin, which he refused. He states that these lumps in the buttocks and thigh have never given any pain and that he does not think they have increased in size. In January, 1906, he was referred to Doctor Coley, who removed a section from the mass in the right thigh, which, upon examination, was reported "sarcomatous." He then underwent treatment with Doctor Coley with toxins for ten weeks, at the end of which time he refused further injections. Six months later an ulcer broke out just above the inner side of the left ankle. Mercurials and iodides were used extensively for about ten months without much apparent improvement or relief. During convalescence and recovery from German measles the ulcer healed. A year later another ulcer appeared, 1 inch above the old one. This one took about one and one-half years to heal. In 1911 went to the Presbyterian Hospital. During his stay in the Presbyterian Hospital he was given several doses of salvarsan. Another piece of tissue was removed from the mass in his thigh and pathological report returned states that the mass was mostly cartilage. Later in 1911 the hamstrings at the right knee were cut for marked contractures. Since the operation the knee has been ankylosed. Had Neisserian infection five years ago. Has had 8 Wassermanns taken, all of which have been negative; a Wassermann was taken two or three weeks ago by Dr. Cyrus Field with a highly sensitized antigen, who states that it reacts "slowly negatively." In 1916 he underwent a course of mixed treatment in Bellevue; several months later was advised that mixed treatment was of no benefit. In April, 1917, another ulcer broke out near the site of the first two, which is still active.

Examination.—Patient under-nourished. Shows large irregular, oval-shaped ulcer about 2½ inches long by 1¼ inches wide. It is neither specific, trophic nor decubitus in type. He has marked limitation of motion in all joints of the lower extremities, with both knees in slight flexion and adduction. The X-ray pictures, from the pelvis down, show marked disturbance of the bony structures and apparently two different type lesions are present. From the pelvis up, bones give a mixed gross pathologic picture and are all normal. The two chondro-

osteomatous masses are freely movable in each buttock, and may be regarded as of congenital origin, having nothing in common with the generalized bone lesions.

CASE II.—*Metaplastic osteomalacia, fibrocystic.*

Maurice C., aged sixteen years, reported in detail in ANNALS OF SURGERY, February, 1915. General condition to-day practically the same as in previous report. All blood and urinary tests are negative, all bones above the pelvis are normal. X-ray examination shows slight, if any change, in the pathology of diseased bones. Patient is never conscious of pain or disturbance in lower extremities, does not suffer from weakness or tire easily. Still wears a brace and high shoe on shortened limb. Recent experimental hypodermatic injections of tincture of iodine under the periosteum in the left femur seem to have produced slight localized improvement.

CASE III.—*Localized fibrocystic osteomyelitis, traumatic* (secondary to hemorrhagic osteomyelitis).

Joseph B., male, white, aged twenty-two years. First noticed an oval-shaped lump, size of a small hen's egg, on inner condyle of right femur early in January, 1915. There was little or no pain except on pressure over the lesion; slow increase in size was noted until April in the same year, when it was the size of a large hen's egg. At this time patient fell from a height of 20 feet and fractured the femur along the inner side of the lesion, the fracture extending into the knee-joint. Patient was first seen at the New York Hospital for Ruptured and Crippled in October, 1915, seeking relief for limitation of motion in right knee-joint. He states that the lump on the inner side above the knee has not increased any in size since the accident and that it does not bother him in any way. Another X-ray, taken early in 1916, shows no increase in size of the lesion and no symptoms of activity.

CASE IV.—Localized area of *osteolysis* in lower end of left tibia.

Francis D., male, white, aged thirteen years. Localized pain five weeks. Operation refused. Lost sight of. See röntgenogram Fig. 9.

CASE V.—Localized *fibrocystic osteomyelitis,* right olecranon, secondary to hemorrhagic osteomyelitis.

Pauline D., female, white, aged five and one-half years. Reported in detail (*Surgery, Gynæcology and Obstetrics,* July, 1914). See röntgenogram Fig. 10.

CASE VI.—Localized *fibrocystic osteomyelitis,* right tibia, upper end, secondary to infectious polyarthritis and multiple osteoarthritis.

William B., male, white, aged twenty-nine years. Polyarthritis when eighteen years old, several recurrent attacks since. Lumbodorsal spine rigid, limitation of motion in hips, free from pain in spine since pathologic fixation in bowed position. Localized spot near knee-joint very tender on pressure. See röntgenogram Fig. 11.

CASE VII.—*Bone cyst,* upper end of femur (left), secondary to hemorrhagic osteomyelitis.

Francis M., male, white, aged six years. Reported in detail in ANNALS OF SURGERY, February, 1915. See röntgenogram Fig. 12.

CASE VIII.—Localized area of *osteolysis,* upper end humerus.

David S., male, white, aged five years. History and symptoms nega-

FIG. 1.—Case I. Metaplastic osteomalacia. Shows destruction in pelvis and femoræ. The two masses below the pubes are separate and distinct neoplastic processes, clinically chondro-osteomata. They are unattached and freely movable in the buttocks, and had remained practically stationary in size for years.

FIG. 2.—Case I. Metaplastic osteomalacia. Showing practical obliteration of knee-joint.

FIG. 3.—Case I. Metaplastic osteomalacia. Note practical absence of cystic areas in tibiæ and fibulæ. Paget's disease type.

FIG. 4

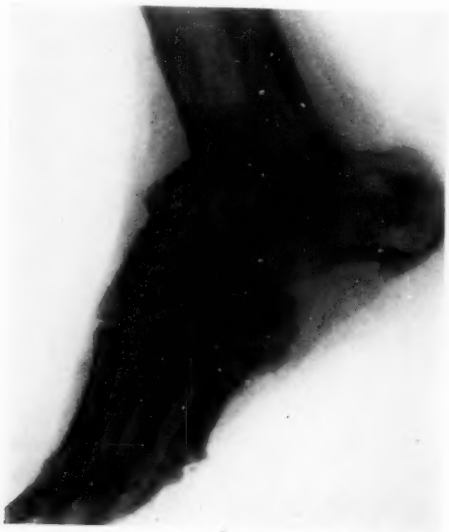

FIG. 5

FIGS. 4 and 5.—Case I. Metaplastic osteomalacia feet.

FIG. 6.—Case I. Raymond C. Photo shows side view of lower extremity in slight flexion, chondro-osteoma in buttock and protruding trochanter.

FIG. 7.—Case II. Metaplastic osteomalacia. Fibrocystic type, femur and ilium.

FIG. 8.—Case III. Fibrocystic osteomyelitis, secondary to hemorrhagic osteomyelitis. Lower end of femur. Note fracture into joint.

FIG. 9.—Case IV. Localized area of osteolysis. Lower end of tibia.

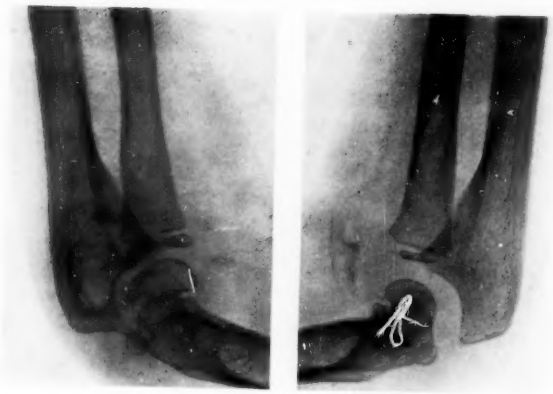

FIG. 10.—Case V. Fibrocystic osteomyelitis, secondary to hemorrhagic osteomyelitis.

FIG. 11.—Case VI. Localized fibrocystic osteomyelitis, secondary to polyarthritis and multiple osteoarthritis. Lesion is shown in upper end of tibia.

FIG. 12.—Case VII. Localized cystic osteomyelitis, secondary to hemorrhagic osteomyelitis.

FIG. 13.—Case VIII. Area of osteolysis. Middle third of the humerus. Symptom of onset-fracture.

FIG. 14.—Case IX. Lesion in the femur. Patient suffering from congenital syphilis.

tive until brought to hospital suffering with pathologic fracture. Patient was simply splinted with plaster-of-Paris support; no operative anatomic proof of the precise pathology was obtained, therefore a positive diagnosis was impossible. See röntgenogram Fig. 13.

CASE IX.—Localized area of *osteolysis*, middle third right femur, in patient giving a positive Wassermann (Pat. of J. R. Brooke).

M. J., female, white, aged fifteen years. Fracture of thigh eight years ago, occurred while patient was stooping, tripped and fell on leg. For several years practically free from trouble. Pain and discomfort began in thigh ten months ago. Antispecific therapy gave immediate relief and lesion is becoming smaller. See röntgenogram Fig. 14.

CASE X.—Localized area of *osteolysis* in upper end of tibia in a largely distended hæmophilic knee, condition not suspected, revealed on X-ray examination of joint.

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TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

Stated Meeting, held January 9, 1918

DR. CHARLES N. DOWD, President *pro tempore*, in the Chair

MULTIPLE RECURRING FIBROMATA

DR. WINFIELD S. SCHLEY presented an adult woman who, thirteen years ago, had developed on the side of her third toe a tumor the size of a small lemon. A similar tumor had formed in the skin of her back and had been excised some years before. In the scar left by this operation were now small nodules. Before this the heel also had become thickened and had developed a flat tumor formation.

In 1909 the toe tumor was excised. It was not attached to the bone, and was covered with stratified squamous epithelium and epidermis. A few small spindle-shaped nuclei were noted in its stroma. The blood-vessels were very scanty.

Two years after the operation of 1909 the heel began to show considerable growth. On entrance May 17, 1917 (eight years later), there was a large local recurrence involving the third toe. There were some small nodules on the inner side of the foot below the internal malleolus and behind; on her back, nodules in an old scar. There was also a hard small tumor mass on the forearm an inch long by half inch, apparently arising from deep fascia. It was excised first under local anæsthesia and showed simply fibroma.

Operation (May 23, 1917).—The third toe was removed by a long V-incision, including the removal of the head of the metatarsal. The large heel tumor was easily removed. Growth arising apparently from the deeper layer of skin or heel fascia. There remained a good fat pad. All the growths which had been excised proved to be pure fibromata without any indication of a fibroma-sarcoma.

MULTIPLE OPERATIONS FOR GALL-STONES

DR. IRVING S. HAYNES presented a man, aged forty years, who in April, 1916, was subjected to cholecystectomy and appendectomy.

A post-operative ventral hernia followed the cholecystectomy, for the repair of which operation was done at the Park Hospital in December, 1916. Extensive adhesions involved the biliary region and 6 ounces of sterile mineral oil were poured into the region. Suppuration delayed the healing of the wound, but it finally closed, and the patient left the hospital in January.

In April, 1917, the patient was again admitted to the Park Hospital complaining of pain in the upper right quadrant of the abdomen that extended through to the back and right shoulder. This pain had begun in March,

would come on every two or three days. There was no vomiting, no constipation, but the stools were clay colored. The patient was jaundiced and had lost 50 pounds in the last thirty-five days.

On April 25 the third operation was done, consisting of an exposure of the common duct from which a calculus half an inch in diameter and about an inch long was removed. Careful search of the common and hepatic ducts showed no other stones. Recovery was uneventful and the patient left the hospital at the end of the fourth week.

On June 2 he was again admitted to the hospital with a large abscess in the right hypochondrium. This was incised and drained, constituting the fourth operation. He left the hospital with a sinus.

In the following September he was readmitted to the hospital with a persistent biliary fistula. This discharged a very large amount of bile and pus. His blood examination showed a white cell count of 16,500; polymorphonuclears, 82 per cent.; small lymphocytes, 13 per cent., and large lymphocytes, 5 per cent.

At this time he first came under the care of Doctor Haynes. Examination showed nothing except a number of scars in the biliary region and a deep fistulous tract from which bile flowed continuously. The patient's general condition was fair. In order to be prepared against possible contingencies a donor was found for blood-transfusion and her blood tested out and found to harmonize with that of the patient.

On November 1 was attempted the fifth operation. Inasmuch as the usual route to the gall-bladder region had been traversed so often the incision was made parallel with and just below the costal border, directly through the abdominal muscles. This gave ready access to the common duct from the side and beneath the dense adhesions which extended forward to the anterior abdominal wall. The common duct was exposed. It was almost as large as the duodenum. Its walls were an eighth of an inch thick. A large calculus was felt in the duct. The duct was incised for an inch and a half and a calculus, an inch in diameter, easily removed. It was a dark and very soft stone. A second calculus, half an inch in diameter, was found and removed from the ampulla. A large probe was then passed into the duodenum and this followed by an artery clamp, by opening which the sphincter of the duct was divulsed. This was done so as to be sure and secure a free canal into the bowel for the escape of bile.

A careful search, with probes, scoop and finger, of the common and hepatic ducts failed to show any more calculi.

A T-shaped drainage tube had been constructed beforehand. The tubing was one-quarter inch calibre, the short arm about 5 inches long and the long arm about 8 inches. The short part was placed so that it extended from the hepatic duct, through the common duct into the duodenum. The incision into the common duct was partially closed and the region drained by additional wicks of rubber tissue and a small strip of iodoform gauze. The uncontrollable oozing and excessive hemorrhage that was feared did not occur at this time.

The patient progressed well until the fourth day, when blood began to appear through the drainage tube. On the following day almost pure blood escaped, the patient complained of severe pain through the region of the wound and he began to show marked signs of anæmia. These signs of internal bleeding did not diminish even after the use of serum and the region of the operation was distended and painful. Therefore, on November 7, after a preliminary transfusion of 900 c.c. of blood by the syringe method by Dr. Lester Unger, the sixth operation was attempted in a patient nearly moribund.

The entire wound was reopened; foul blood, fluid and clotted with bile and pus to the amount of probably a quart was cleaned out. The T-tube was removed, the wound was repacked loosely with washed iodoform gauze and several drains of folded rubber tissue placed at the lower angle of the wound and the edges brought together by through-and-through sutures of silkworm gut. The subsequent convalescence was very slow, but not stormy. Healing progressed unexpectedly rapidly and at the end of the second week all drainage was out of the wound. Bile appeared in the stools after the third day.

At the end of three weeks the patient was out of bed, his stools were normal and the wound had nearly closed. He left the hospital on December 16, 1917, apparently cured. The reporter called attention to the rapidity with which the soft calculi, removed, had formed; to the very satisfactory exposure and convenience offered by the incision below the costal margin; to the delayed secondary bleeding and to the undoubted benefit obtained by the transfusion of whole blood. He believed that without this precaution the patient would not have survived. Finally, to the solid condition of the scar, although healing took place after suppuration and by granulation, the wound seems perfectly solid.

Dr. Lucius W. Hotchkiss stated that he had had a somewhat similar experience a few years ago in a case in which a cholecystostomy was first performed, by another surgeon, with drainage. A sinus had persisted for a long time, then closed, and a resulting infection later necessitated a cholecystectomy and choledochotomy, at which time two large stones were found in the common duct which had not been discovered at the first operation, and their removal was followed by a descent of sandy material from the common duct. The patient apparently made a perfect recovery after long drainage of the common duct, but it was later learned that he was again operated upon about a year later with the removal of another large stone from the common duct. He believed that in such cases, where the common duct is found to contain a quantity of this sandy material, it is probable that a recurrence of stone formation may take place.

PULMONARY FISTULA

Dr. Willy Meyer presented a man, aged twenty-four years, who came under his care in November, 1916, with the history that he was taken sick, with pain in the left shoulder region, early in September, 1915. Pain was increased on breathing. After a few days it was present along the entire

left chest; nineteen days later it was necessary for him to take to his bed, as high fever and rapid pulse had set in with choking spells and expectoration of a sputum of brownish color. Early in October a diagnosis of pneumonia was made. Later this was changed to that of advanced tuberculosis, although two tests of the sputum had failed to reveal tubercle bacilli. Patient's pulse stayed high, temperature was in the neighborhood of 104, sputum voluminous, exhibiting a distinctly unpleasant odor. Two months after the onset of the trouble the fever suddenly subsided. Patient was out of bed, with lessened cough, but pulse still rapid; expectoration continued, the bad odor being constantly present, at times also blood. In February, 1916, he left for the country. There, early in March, he suddenly had a coughing attack which lasted almost six hours and was accompanied by the expectoration of blood. Later he had a more severe hemorrhage, and a few weeks later a regular choking spell; during this attack the odor was so terrible that it was impossible for anyone to remain in the room. Early in June, that is, nine months after the onset, a swelling was noticed just below the left clavicle, which gradually grew to the size of an orange. It was diagnosed as abscess of the left lung, incised and drained; no improvement. If he sat up the coughing spells became very severe. He grew weaker and weaker, and the odor from the sputum was very offensive. In November, 1916, he came under Doctor Meyer's care at the German Hospital. At this time, over a year from the onset of his trouble, he weighed but 90 pounds. He had a continuous cough, day and night. From his experience with similar cases Doctor Meyer advised, weak though the patient was, that he assume mornings and evenings a pronounced chest-elbow posture, for thorough expectoration. Following this he experienced the first quiet night he had had for a long time. It was decided to enlarge the fistula and search for the opening into the thorax under regional and local anæsthesia. The operation was technically very difficult on account of continuous coughing spells, and had to be discontinued after the performance of the following steps: The fistula was used as the port of entry; an incision was made, a finger passed beneath the pectoral muscles and these muscles split up to the clavicle; in the second intercostal space there was found a very small granulation and through this was passed a probe into the thorax. It entered a cavity inside, which, in view of the large amount of sputum frequently expectorated, was thought to be due to an empyema. On enlarging this opening as far as possible, the examining finger passed into a very irregular cavity with septa; it was evident that the lung tissue had been invaded. The wound was drained and packed. Soon there was less cough and expectoration. Two weeks later he had such a severe spontaneous hemorrhage from the wound that it was thought he had little chance for recovery. The wound was packed tightly with iodoform gauze and compressed. With intravenous infusion and subcutaneous stimulation he responded; during that night he had a second hemorrhage. On the following morning a transfusion of 800 c.c. of blood from his father was given. The tightly packed wound was left alone for ten days, and on removal of the

gauze there was no recurrence of the hemorrhage. The odor from the sputum had entirely disappeared. Steady improvement now set in; but soon the wound contracted and with it some bleeding and slight odor returned. It was then decided to make permanently a wide opening which could not contract. At this time blood-pressure was below 100 mm. Hg.

On December 23, 1916, again under regional and local anæsthesia, Doctor Meyer reformed the original skin-muscle flaps, resected the third rib and with an incision in the bed of the same exposed the interior of the chest, providing a good view of the lung tissue. Tamponade was done and the flaps allowed to drop in and gradually join with the pleura. Following this there was steady improvement. This summer he was in the country and his improvement continued. He has gained many pounds. When he closes his mouth and compresses the nose he can breathe for hours through this lung fistula.

By increased ventilation of the diseased lung tissue the offensive odor which practically ostracizes these patients, was here again overcome, an observation Doctor Meyer had made repeatedly. He referred to another patient, a young girl, whose case he had reported previously, who had been practically isolated in an institution for months, and in whom drainage of some of the bronchiectatic cavities was followed by disappearance of the terrible odor. In the case now reported it totally disappeared.

The case, it seems, has to be looked upon as one of central subacute (embolic) pneumonia, with subsequent gangrene of the lung. By the operation described the condition was later transformed into a lung fistula. The opening leads into the upper lobe of the left lung. Under illumination large cavities secreting an extremely small amount can be seen.

It is necessary to differentiate between bronchial fistula and lung fistula. The case presented is one of true lung fistula, since the opening leads directly into large cavities within the lung.

The patient is at present in excellent condition, ready to start work in the northern part of the state. Further operating has been advised against for the present.

Should the patient get tired of his condition or uncontrollable recurrence of expectoration or hemorrhages set in—which at present does not seem likely—lobectomy will be indicated.

Dr. Nathaniel W. Green said that he had seen a few cases of this kind in which the diagnosis of chronic lung abscess had been based chiefly upon the character of the cough and the odor. There was one exception in a recent case which he hoped later to show before the Society. The patient was an Italian who was coughing up purulent material mixed with bile through a bronchial fistula; possibly the mixture of the bile with the pus was accountable for the lack of odor accompanying the expectoration. Operation disclosed a bronchial fistula leading into a lung abscess which in turn was continuous with an old empyema cavity which in turn had a little opening through the diaphragm about as large as a lead pencil leading into the liver, where there was a cavity about the size of a small orange. This

area was drained with tubes, one set leading into the liver cavity and one set leading into the empyema-lung abscess cavity. The patient gained weight and the discharge greatly diminished.

DR. W. S. SCHLEY stated that he had one case of bronchial fistula in a patient with empyema previously operated upon three times, the drainage wound being allowed to close too soon in each instance. When seen by Doctor Schley he was expectorating bad smelling material and draining from a pin-hole chest sinus over the empyema. He was drained externally and in about four weeks the bronchial opening closed. Then, by the use of aspiration drainage, his cavity was entirely obliterated, although this was considerably over a year from the time of his first operation; he made an excellent recovery. Aspiration drainage Doctor Schley considered very essential in all empyema cases. The above case was recorded and the method of aspiration drainage in an article in 1907.

SPLENECTOMY FOR BANTI'S DISEASE

DR. JOHN F. ERDMANN presented a woman, forty years of age, from whom was removed a spleen for Banti's disease, September 28, 1917. Unfortunately, no blood count was taken preceding the operation. There was a large fixed tumor occupying the site of the spleen. The woman had lost a great amount of flesh and was suffering from pain along the upper left quadrant. At operation this mass proved to be a spleen which was densely adherent to all of the surrounding structures. It was removed. It was necessary, owing to the adhesions, to remove a small section of the stomach, a hole about the size of a silver quarter being made. It was also necessary, owing to the dense adhesions, to remove about three-quarters of an inch of the tail of the pancreas. On the thirteenth day after operation she had a dehiscence of her abdominal wound, with some evisceration. The separation was repaired immediately by suturing with three or four through-and-through silkworm stitches.

Her first blood count, immediately after operation, was 4,000,000 reds, 6,000 leucocytes, and 34 lymphocytes. Nine days after the operation her blood count was 4,000,000 reds, 12,500 whites, with 75 per cent. hæmoglobin.

OBSTRUCTIVE (MALIGNANT) JAUNDICE

DR. JOHN F. ERDMANN read a paper with the above title, for which see page 274.

DR. FREDERIC KAMMERER stated that he had operated upon two cases of cancer of the ampulla of Vater; in one case, eleven years ago, he had attempted to remove a tumor about the size of a hazel-nut by incising through the duodenum; the tumor was finally removed by resection of the end of the common duct. The latter was reunited with the duodenum by sutures and a cholecystenterostomy was also done. The patient seemed to be doing well, when he suddenly collapsed, on the second day after operation, and died. No autopsy could be obtained. The second case was operated recently; on opening the abdomen the common duct was found to be about the size of an index finger, and by liberation of the duodenum a very easy approximation of the common duct with the duodenum was obtained and a chole-

docho-duodenostomy was performed. The gall-bladder was not drained in this case and everything went well for about five days, when on removing the dressings it was found that at least some of the sutures at the anastomosis had given way and a large amount of bile escaped from the wound. After the lapse of a day or two a duodenal fistula developed, with characteristic discharge from the sinus in large amounts. Rather suddenly the drainage stopped after a further week; the intense jaundice had almost cleared up and continued to disappear until it was entirely gone. There was at no time any further discharge from the wound, which closed rapidly. The patient, unfortunately, died, at the end of six weeks, from a lung abscess. In this case, evidently, some of the sutures at the anastomosis had given way, but the final result was not impaired, as regards the proper functioning of the anastomosis, an observation which others have also made.

Dr. Willy Meyer agreed with Doctor Erdmann that operation was indicated in every instance of obstructive jaundice, and said that he had united the gall-bladder with all the organs mentioned by the author with the exception of the colon; he had only once united it with the stomach. He called attention to the fact that in his opinion the danger lay not with the anastomosis, but with the chronic jaundice which is so apt to predispose to a serious hemorrhage; and he advocates subcutaneous infusions of 3 to 4 ounce amounts of human blood serum on the three successive days before operation or pre-operative transfusion as most efficacious in the prevention of this post-operative parenchymatous hemorrhage. All cases of chronic jaundice should be tested for their coagulation time, and if this is found to be abnormal *pre-operative* precautions as outlined should be taken.

HYDRONEPHROSIS

Dr. Lucius W. Hotchkiss presented a specimen of hydronephrosis of the kidney, showing well the cause of the hydronephrosis, there being a small calculus shaped like a short horseshoe nail with the point of the nail passing down into the ureter and the head of the nail in the pelvis of the kidney. The patient, who was thirty-four years of age, had suffered from irregular symptoms since childhood. On admission to the hospital there was discovered a movable right kidney and a lumbar incision disclosed an unsuspected hydronephrosis.

RECONSTRUCTION OF THE BILE-DUCTS

Dr. John F. Erdmann presented X-rays of the following two cases:

Case I.—A woman, thirty-four years of age, who was operated, first for cholecystitis, on June 14, 1917, at which time an ectomy was done. The doctor who operated her stated that in trying to stop a hemorrhage from the cystic artery he had evidently included a portion of the hepatic duct. She was jaundiced three days after her operation, never having been jaundiced before or had any pain. Then there was a biliary discharge which started up within a day or two after the jaundice and kept up for about seven weeks. Closure for three weeks. Wound broke open again and

leakage began again and persisted until October 25, 1917, when she was operated in a hospital in New Jersey. Nothing apparently was accomplished and the patient came under observation on November 28. She was badly emaciated, with no jaundice whatever, with an excessive leakage of bile, and two parallel scars in the upper right quadrant, the original scar containing the fistula.

Operation was done on December 3, showing a marked mass of scar tissue in the deep wound. This cicatrix occupied the site of the common duct fully 7/8 of an inch long. The sinus led into the duodenum. After tedious dissection the hepatic duct was demonstrated. A catheter was introduced into the hepatic duct, the overlying cicatricial tissue was split so as to bury the catheter in this tissue and allow the distal end of the catheter to be passed into the duodenum, fully six inches in length. Two sutures of chromicized catgut were placed through the catheter, sewing over the surrounding tissues of the duodenum and the contiguous portion of the stomach. Some omental tissue was sewed around the exposed portion of the catheter. Four weeks and six days after operation the patient passed catheter by rectum. There was a leakage of bile from the wound for about three days.

CASE II.—The patient was a woman, thirty-nine years of age. She had been operated some time about the middle portion of 1916. Seen in consultation about six or eight weeks after she had returned home, at which time she was suffering from a deep jaundice. No history of pain—a gradual onset, in other words. No sinus or fistula. She became pregnant in the latter part of 1917 and aborted. At this time she was intensely jaundiced and suffered acutely from pruritus. Seen again on November 30, 1917, at which time she was markedly jaundiced and pigmented and was suffering so that she demanded some operative procedure.

Operation.—Upon cutting over the region of her common duct there was found a destruction of the hepatic duct to such a degree that nothing but cicatricial tissue was left. The liver was markedly engorged. (She had, incidentally, lost 27 pounds in weight.) This cicatricial band was the hepaticus in part and the upper portion of the common duct. After much difficulty the upper portion of the hepaticus was demonstrated. Then a filiform probe was pushed down to the common, first rotating the duodenum. A catheter was placed in the hepaticus and then passed through the common and buried in the cicatricial tissue, occupying the position of the lower portion of the communis, then passed fully 6 inches into the duodenum, the tissues around being sewed in after the same fashion as was done in the other operation, reported above. There was absolutely no drainage whatever of bile in this case, except a few days ago, since which time she has been doing nicely.

DR. IRVING S. HAYNES said that in 1913 he had a similar case to those reported, where a surgeon, doing a cholecystectomy, had resected three-quarters of an inch of the common duct. When he later was operating this patient he found the common duct after an arduous search and inserted

a one-quarter-inch drainage tube from the hepatic duct and through the common duct to the duodenum. The patient died from persistent oozing within forty-eight hours in spite of serum treatment. He said that he did not at that time know sufficiently about the preventive treatment of post-operative hemorrhage in severe jaundice by whole blood transfusion, for although he used horse serum in this case it was ineffective.

Dr. Lucius W. Hotchkiss said he had had two cases of division of the common duct; the first case occurred in the exploration of the upper abdomen for supposed gall-stones; the patient had no stones, but was suffering from tuberculous peritonitis; in the search for stones the common duct was accidentally divided; an immediate end-to-end anastomosis of the common duct resulted in recovery. The second accident occurred in a case during extirpation of a cyst of the head of the pancreas to the right of the descending duodenum, and in ligating the pedicle, which extended deep into the head of the pancreas, the common duct was opened near its entrance into the duodenum. This was recognized, partly covered in, but a biliary fistula developed. In an attempt to repair this defect two months later the duodenum was mobilized, and a peritoneal and muscular flap was taken from the stomach and pylorus, turned over the opening into the bile-duct and stitched, after tying a ligature around the common duct above the fistula; following this a cholecystenterostomy was performed. There was some slight leakage a few days later, but the patient made a satisfactory recovery and complete closure of fistula was obtained.

Dr. Nathaniel W. Green referred to Dr. Arthur G. Sullivan's procedure for repair of the common duct, in which he used on his catheter a bit of rubber sponge, by which when inserted in position the peristalsis of the gut and the tug on the sponge loosened up the catheter, and the same result was obtained as by Doctor Erdmann with his long catheter.

DEVICE FOR DRAINAGE IN EMPYEMA

Dr. Theodore Dunham presented a drain which consisted simply in the use of the Furniss spool drain, making a valve by attaching a piece of sheet rubber to the external end. This flap does not interfere in any way with the drainage, as it is forced out during expiration; during inspiration the flap drops back into the opening, producing a definite negative pressure in the chest. Its use is particularly advocated in infants and young children.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting, held November 5, 1917

DR. CHARLES H. FRAZIER, President, in the Chair

PROLAPSE OF THE RECTUM

DR. T. TURNER THOMAS said that in the *Zentralblatt für Chirurgie,* 1909, xxxvi, 1225, P. Sick offered a simple and apparently rational operation for prolapse of the rectum. Since that time Doctor Thomas had operated at the Philadelphia General Hospital on three or four cases by the Sick method besides the cases here reported, and had excised the prolapse in two others. He had not been able to follow any of these cases after they left the hospital. Very satisfactory results were obtained in the two cases in which the prolapse was excised, but the operation was time consuming, rather bloody, and in one it was observed that the rectovesical pouch of peritoneum was included in the excision. One must also consider the possibility of a stricture following this operation.

The Sick operation is much more quickly and easily performed, is more safe and is perhaps as effective. Sick describes it as follows:

> A longitudinal incision is made in the raphe between the end of the coccyx and the circular fibres of the sphincter ani muscle, where there are no vessels, nerves or muscular fibres to be injured. The superficial fascia and deep fascia are divided, and the loose connective tissue behind the rectum exposed. The rectum is then separated on its posterior wall by a suitable instrument as high as the promontory of the sacrum. In the cavity thus made, a strip of iodoform gauze of four to six thicknesses is laid and the small external wound protected from the anus by an adhesive plaster or collodion dressing.

The reporter had extended the incision alongside the coccyx when necessary. When Sick says that no muscle fibres need be divided he loses sight of the fact that the levator ani must be cut through. With good retraction of the wound one can readily denude the posterior wall of the rectum from one side to the other with the finger and can make a wide denudation of the anterior wall of the sacrum well up into its curve. He did not use any instrument for a higher denudation, believing that that accomplished by the finger on the rectum and sacrum would be ample for a permanent cicatricial adhesion of the rectum to the sacrum. The opportunity afforded to the sphincter ani to recover its normal tone is probably an important

factor in the permanent result. He had not protected the wound from anal infection by an adhesive plaster or collodion dressing, but had in the recent cases, moistened with alcohol the gauze packed into the wound, and had depended chiefly, for protection against infection, upon the prevention by opium of bowel movements for four or five days when granulations have developed over the wound surface. The perfectly dependent drainage is also a very important factor in this connection. In no case has there been any disturbance from infection and in all cases the healing has been rapid. The first case presented was a boy, six years old, an imbecile, who was transferred to the surgical ward September 27, 1917, because of an almost constantly recurring prolapse of the rectum of about a year's duration. The mother says that when the child was at home the reduction of the prolapse was always difficult. On one occasion while in the hospital the prolapse was accompanied by "violent and profuse hemorrhage," but this ceased immediately after reduction. The Sick operation was performed October 13, 1917. Packing removed from wound five days after operation and wound not packed at all afterwards. It was completely healed in two weeks and there has not been the slightest recurrence of the prolapse.

The second case was a woman, fifty years old, an epileptic who had had a prolapse of the rectum for ten years, which protruded three to three and a half inches. At first the patient could reduce it herself, but is no longer able to do so. It comes down on every movement of the bowel and at time of operation, October 27, had been down for about forty-eight hours. The operation was performed under gas-oxygen anæsthesia, and because of the difficulty of keeping the prolapse reduced the operation had to be done without reduction, the prolapse being covered by a piece of gauze and the reduction being maintained afterward by the packing of the wound tightly with gauze moist with alcohol. Two silkworm stitches were employed to close the lower part of the wound. The packing was removed in a week. There were no signs of infection and the patient did not complain of any pain in the wound, nor of any tendency of the prolapse to recur.

Dr. John B. Roberts said that it seemed to him that this operation was adapted only to mild cases. About twenty-five years ago he himself had devised and performed an operation for prolapse of the rectum which was original. The first operation was done at the Woman's Hospital of this city. The method was described in the Annals of Surgery and in his "Modern Surgery." Other operators have since practised it satisfactorily. It is intended for severe cases of prolapse of the rectum with great dilatation of the anal aperture. The dilated orifice of the anus is reduced in diameter by cutting out a portion of the sphincter with the perineal skin at its posterior part. The skin incision, which is V-shape, has its apex at the point of the coccyx. By burrowing in the cellular tissue behind the rectum with fingers and scissors, the surgeon is able to reach the posterior wall of the rectum for a distance of several inches, thus sepa-

a. *b*. *c*.

FIG. 1.—*a*. Case II. Before operation, showing prolapse of rectum. *b*. Case II. Two days after operation. *A*, gauze protruding from wound; *B*, anus—two silkworm-gut sutures between *A* and *B*. *c*. Case I. Scar in median line three weeks after operation. Complete healing in two weeks.

rating the gut from its attachment to the hollow of the sacrum. A sufficient V-shape portion of the posterior wall of the rectum is excised, the point of the cut-out V reaching several inches upward from the external opening of the intestine. After hæmostasis, the rectal wall is sutured from apex downward with chromicized catgut sutures and the stumps of the excised sphincter similarly united; after which the skin is closed back to the end of the coccyx, leaving, however, a space for the insertion of a drain. This excision of the rectal structures, by two V's with their bases together at the anus, converts the lower end of the intestine into a funnel-shaped tube and contracts the anus by lessening the diameter of the sphincteric ring. There is little opportunity, therefore, for the intestine to be thrust downwards and through the anus. The operation is intended for complete prolapse and is satisfactory for adults and even occasionally might be used in severe prolapse in children.

Dr. George P. Müller called attention to the paper of Lockhart Mummery, describing an operation similar to the Sick operation. Doctor Müller had operated four times by this method and knew that it was successful in all of them up to thirteen months ago. This operation consists of a transverse incision an inch long between the tip of the coccyx and anus. The rectum is separated from the hollow of the sacrum and the cavity is packed with gauze to produce adhesions of the posterior wall of the rectum to the sacrum. This is the simplest operation one can do in children with prolapse. In the case of one adult in which he did this operation there was recurrence. In adults he performs the operation of Moschcowitz and had operated thus on five adult patients, with cure in all, so far as he knew. One case occurred in a colored boy who had had the prolapse for twenty years. It was eight inches long and yet was easily pulled up and for the past two years has shown no sign of recurrence. The only trouble with this operation is the difficulty in doing it. The pelvis is so deep and, especially in the male, one has to reach far to the bottom of the pelvis to insert the first pursestring suture. In males also it is difficult to place more than two and sometimes three pursestring sutures. In the female it is easier because of the ability to use the uterus to obliterate. By plastic work on the peritoneum one can cover all the opening so that the intestine cannot herniate in any little pockets afterwards.

Dr. Thomas, in closing, said that it seemed to him that the reason that in children prolapse will so often disappear permanently without operation after the bowel has been kept up for a long time, is that the sphincter regains its control, and the severe tenesmus which caused the prolapse does not recur. He could not see that merely taking a piece out of the adult sphincter, long stretched, thinned and almost hopelessly paralyzed by the prolapse, and sewing the rest together is going to help much in preventing recurrence. If any operation could keep the prolapse up long enough to permit the sphincter to fully regain its normal tone, this secondary result would assure a permanent cure. The long and wide cicatricial adhesion provided by this simple operation, between the sacrum and rectum just where

the causal relaxation between them exists, ought to give the best possible support for this condition.

NEPHROLITHIASIS WITH PERINEPHRITIC ABSCESS

DR. J. BERNHARD MENCKE presented a woman, twenty-one years of age, who ten months ago had an attack of severe right lumbar pain, which subsided after a few days. Two months ago she had a child. From the third to the seventh day after delivery she ran a temperature. When admitted she stated that she had suffered from pain referred to the right side of her abdomen for three weeks. Her temperature on admission was $100^{2}/_{5}$. Leucocytes, 8,500. In the upper right quadrant of the abdomen extending into the loin was a tender nonfluctuating mass. X-ray showed numerous calculi in the right kidney. Cystoscopic examination by Dr. Tracey showed an œdematous right ureteral orifice surrounded by a zone of congestion. No urine obtained from the right side; normal on the left side. After preliminary treatment she was subjected to operation upon August 10, 1917. Lumbar incision opened an abscess cavity from which a number of calculi were removed. In the substance of the kidney proper there was an opening large enough to admit two fingers through which three more calculi were removed. Wound closed with tube drainage. Uneventful recovery. Eventual healing without sinus.

APPENDIX IN SAC OF INGUINAL HERNIA

DR. J. BERNHARD MENCKE presented a man, twenty-two years of age, who had had a right inguinal hernia since infancy. It was now the size of a small orange when down.

When the hernia was reduced, the testicle also could be placed entirely within the abdominal cavity, apparently traversing a short inguinal canal. An examination of the blood having shown a normal coagulation time, operation was undertaken. Upon opening the sac its sole contents was found to be the appendix, the sac extending to near the base of the meso-appendix and the cæcum being far down back of the sac. An appendectomy was done. One testicle was found to be about one-half the normal size, the epididymis well developed. The testicle in its descent had come forward not as with a cord but with its peritoneal covering the wall of the sac flanging out to a broad base behind it. This was split and folded back, sacrificing the veins, and then the sac closed above and the hernial repair completed.

The convalescence was complicated by excessive oozing within the wound. This necessitated opening it superficially, closure being followed by primary union. The oozing continued for eight days, the coagulation time still being only three minutes. When the clot was evacuated capillary oozing was still taking place and a gauze wick inserted. Healing ensued and the ultimate result was good, although the testicle remained in the upper part of the scrotal sac.

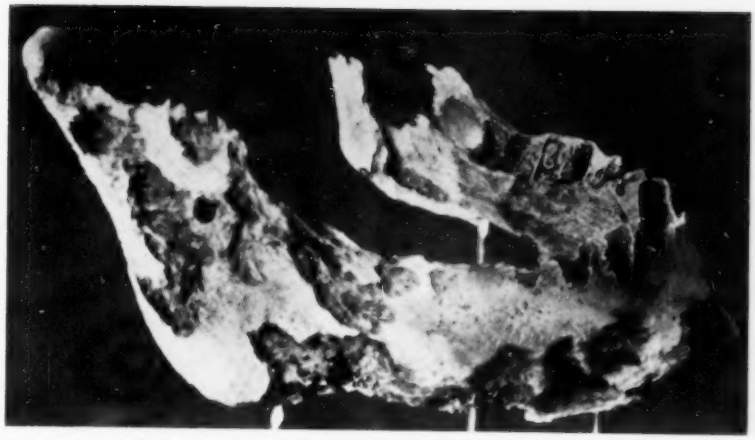

FIG. 2.—Sequestrum showing complete necrosis of mandible.

FIG. 3.—Restoration of mandible after complete necrosis.

NECROSIS OF THE MANDIBLE

END RESULTS IN EXTENSIVE NECROSIS OF THE JAW

DR. J. BERNHARD MENCKE presented an adult patient who developed an infection after the removal of a left molar tooth. There followed, however, an osteomyelitis of the jaw. The case ran a protracted course and finally there separated several fragments which he presented. One fragment is about 2 x ½ x ¼ inches. The patient shows a good end-result, and illustrates the good outcome of a case treated with extreme conservatism.

NECROSIS OF THE MANDIBLE: REMOVAL OF ALMOST THE ENTIRE BONE AS A SEQUESTRUM

DR. ALFRED C. WOOD presented a girl, aged fifteen years, who was admitted to the University Hospital, January 11, 1917, on account of swelling of the lower jaw and overlying soft parts. The trouble began twelve weeks before with severe "toothache" on the right side of the lower jaw. Subsequently ten abscesses formed, one after another, and opened spontaneously. Ten teeth were extracted at various times. The left side of the lower jaw was incised and a large amount of pus evacuated. At the time of admission the swelling was greatest about the symphysis; the mouth was very foul; there was no pain. The lower part of the face was greatly swollen, especially the chin; the swelling extending into the neck. The upper teeth were in fair condition. All of the lower teeth were missing. Almost all of the alveolar process appeared to be necrotic. The patient was able to take liquid nourishment only. Examination otherwise negative. Red blood-cells, 3,640,000; leucocytes, 23,300; hæmoglobin, 43 per cent. The urine contained albumin and a few hyaline casts. X-ray plates showed necrosis of both sides of the mandible, with an involucrum on the right side only.

The patient was ordered to use a mouth wash very frequently, and was sent home. She was readmitted July 16, 1917. The swelling of the face was much less and the general condition had greatly improved. The mouth was cleaner and could be opened more widely. The necrosed alveolar process was protruding through the mucous membrane throughout.

There was an external sinus at the angle of the jaw on the left side; X-ray examination showed necrosis of the entire lower jaw. The separation of the involucrum did not yet appear complete. She was therefore advised to continue the mouth wash and was discharged.

She was admitted for the third time October 4, 1917. The general appearance of the face had still further improved. The mandible was more exposed by extrusion through the mucous membrane. X-ray examination showed a complete regeneration of bone. Red blood-cells, 4,060,000; leucocytes, 8,320; hæmoglobin, 67 per cent. A trace of albumin and one cast were found in the specimen of urine examined. On October 13, under ether anæsthesia, the sequestrum was removed through the mouth. As Figs. 1 and 2 show, the specimen consists of the entire mandible, except the left articular process and a part of the ramus. The third molar tooth on the left side remains. Rapid improvement followed.

Dr. James K. Young remarked that while the complete reproduction of the bone from any periosteum is a remarkable thing, the most extraordinary instance of it is the reproduction of the clavicle. The entire clavicle can be removed and, if the periosteum is preserved, it will be reproduced. All are familiar with the reproduction of the tibia, femur, and the long bones of the extremities; but, in the jaw and the clavicle this fact is often forgotten. Some years ago he exhibited to the Academy a patient in whom after the removal of the entire clavicle it had been wholly reproduced.

Major Donald McCrae reported two cases of total removal of the scapula including the articular surface, with complete reformation and absolutely normal function. The size of the new shoulder blade was just about half that of the other one, but there was absolutely no difference in function. The humerus was entirely separated.

ACUTE DILATATION AND SPONTANEOUS RUPTURE OF THE STOMACH

Dr. A. Bruce Gill reported the history of a girl, aged sixteen years, who had been for eight years a patient and pupil in the Widener Memorial Industrial Training School for Crippled Children. She had at the time of her death a large fixed cervicodorsal kyphosis, and had been free from any acute symptoms of her disease for four to five years. On January 28, 1916, she complained of nausea following the use of atropine in the eyes for the purpose of refraction. The nausea passed away. On the following morning she had a similar experience following the second dose of atropine. She again soon recovered from the nausea, and seemed to be as well as usual, but she was kept all day under observation on the hospital floor, and her eyes were refracted in the late afternoon. At 7.00 o'clock the same evening she complained of pain in the upper abdomen and began to vomit. Her abdomen rapidly became markedly distended. The vomiting was persistent and her distention increased. No gas or fæces passed by the rectum. The nurse attempted to pass a rectal tube but was unable to enter it more than a few inches.

Doctor Gill saw the patient about nine o'clock. Her abdomen was then in a condition of very great distention, which was general and extended into the flanks and over Poupart's ligaments. Her pulse was 150, but of good quality. She complained of no particular pain except a feeling of tightness in the upper abdomen. Her respirations were not labored and she conversed without difficulty. At intervals she vomited without effort a few ounces of brown-colored liquid. There was no desire for a movement of the bowels.

A rectal tube was passed for a distance of twelve inches without the evacuation of any gas or fæces. While arranging for opening the abdomen, to determine the cause of the obstruction, the nurse came down and said that the patient attempted to turn over in bed and immediately expired.

The following morning a post-mortem examination was made. There was fluid and gas in the abdominal cavity. The small and the large bowels were collapsed. The stomach was partially distended, but a perforation

was present in it on the anterior wall near the greater curvature about two inches below the cardiac end. The stomach contained a considerable quantity of liquid mixed with particles of food. Some of the food was identified as that which had been eaten two days previous. The stomach was nowhere adherent to surrounding structures nor did it present any evidence of ulceration. The mucous membrane was rent in several directions radiating from the point of perforation. The perforation itself was not more than an inch in length.

Evidently the patient had had a rapid formation of gas in the stomach, arising from undigested food which had been present in part for at least forty-eight hours. The stomach, for some reason or other, did not empty itself into the duodenum. It does not seem probable that the atropine placed in the eyes was sufficient to paralyze the involuntary muscles of the stomach. And yet the patient experienced nausea on both days after the use of the atropine. After the distention began the stomach could not empty itself into the bowels either because of pyloric spasm or because of a kinking at the pylorus due to the distention. As the patient lay in bed the pressure within the stomach was sufficient to force back through the cardiac end some of the large amount of fluid present in it, but none of the gas. Finally the wall of the stomach became so distended that the effort of turning over in bed caused it to rupture, with instant death of the patient.

On looking through the literature of the past twenty years, as recorded in the *Index Medicus,* he could find no case entirely similar to this one. As a matter of fact, there is but little literature on the subject. Hartmann, in the *St. Louis Medical Fortnightly,* 1906, p. 613, records the case of a woman who probably died of spontaneous rupture of the stomach. She had for three years been trying to reduce her weight by eating something and drinking vinegar, and the post-mortem examination showed extreme atrophy of the walls of the stomach. Paul Fraenckel, in *Deutsches Archiv für Klin. Med.,* 1906, lxxxix, p. 113, discusses a series of cases of rupture of the stomach following long repeated lavage of the stomach, and several following the administration of narcotics. Rupture of the stomach due to ulcer or carcinoma is, of course, excluded from consideration.

Dr. John A. Brooke related the history of a somewhat similar case which was seen by him in a hospital in New York some time ago. The child in whom the rupture of the stomach occurred had been ill for some time and had been wearing a rather high hip spica of plaster of Paris. Following a severe attack of vomiting the child went into a state of collapse and died. The autopsy revealed a rupture of the stomach. It was thought that the plaster acting as a constriction may have had something to do with the rupture.

HEREDITARY MALFORMATION OF THE EAR

Dr. A. Bruce Gill presented three patients, two brothers and their mother, who presented similar malformation of the ears, lop-ears. The mother states that her three sisters, her brother, her father, and her paternal

grandfather all had a similar deformity. There is here, therefore, an authentic history of lop-ear in four successive generations. In October, 1916, Doctor Gill operated upon the ears of these two brothers by excising an elliptical portion of skin and a half-moon-shaped piece of cartilage. As a result, the ears now lie fairly close to the skull. In these two boys the deformity of the ear is a stigma of degeneration, as both are mentally subnormal.

INGUINAL HERNIA COMPLICATED BY HERNIA OF THE OVARY AND TUBE

Dr. George P. Müller reported a case of a child five months of age who had been operated upon nine weeks previously for acute strangulation of the ovary and tube in a left-sided hernial sac. The ovary and tube were removed. Five weeks later her physician noticed a mass in the right side, and as it was feared that strangulation might also occur here Doctor Müller operated four weeks later, the child being then five months of age. Through the usual incision a hernia was found extending into the canal of Nuck, and in the sac was the right ovary and tube. These were gently replaced within the abdominal cavity and the hernia repaired in the usual manner. The child made an uninterrupted recovery.

FOREIGN BODY REMOVED FROM ABDOMEN NINE YEARS AFTER IT HAD BEEN SWALLOWED

Dr. George P. Müller reported a case of foreign body (pin) removed from the abdomen. The patient was thirty-four years of age. Nine years previously she had swallowed a pin, but thought no more of it. Three years ago she began to suffer from pain in the loin and right iliac fossa, together with frequency of urination. At the same time it was noticed that a prolapse of the uterus had occurred. In December, 1916, she was operated on by a surgeon for the latter condition. The operation was unsuccessful and the prolapse recurred. Her symptoms also persisted, and recently she submitted to an X-ray examination, and a stone was found in the lower pole of the right kidney and during the investigation of the ureter the pin was discovered at the level of the right sacro-iliac joint, and about on the course of the ureter.

Operation was performed by Doctor Müller on September 27, 1917. A loin incision was made and the kidney delivered from the wound. The stone was removed without a great deal of difficulty. A second incision was then made through the right rectus muscle and the peritoneum incised to the outer side of the cæcum and the colon and posterior peritoneum reflected from the abdominal wall. Just over the right iliac joint a mass was found which proved to be the pin, lying across, and in direct contact with, the ureter, surrounded by some exudate and containing some calcareous material. The pin and the exudate were removed and the cæcum stitched back into place. A tremendous mass of adhesions was noted in the lower abdomen, the result of the previous operation (probably a Hirst operation

through a Pfannenstiel incision). The patient made an uninterrupted recovery.

Dr. Addinell Hewson reported an end-result of a condition found in a cadaver. The patient had been an inmate of an insane asylum and there were found in her abdominal cavity seven hairpins. The condition presented was that apparently of a huge abscess extending from Poupart's ligament to the cartilage of the chest and confined to one side. Examination of the umbilicus showed it to be perfectly cribriform from the openings made by the introduction of the hairpins into the abdomen. Further examination showed that the abscess extended throughout the abdominal cavity, that there was an opening through the upper segment of the rectus muscle about 4 cm. in diameter and that the muscle was entirely eroded. Examining further, it was found that the hairpins, one at least, had gone completely into the intestine. The whole mass was one of intense inflammation with the intestines all bound together. One of the hairpins was entirely within the lumen of the intestine, apparently without doing harm. There was the history that at the institution in which the patient died she had been found in the act of driving these pins into the umbilicus. Some of the pins had not been divested of their shiny covering. They were the usual 2½ and 3 inch pins; some of them with the fluted margins and not absolutely straight.

Dr. J. M. Spellissy said that Doctor Müller's report reminded him of an operation that he had performed years ago and in which the pre-operative diagnosis had hesitated between an inflammatory condition and a chondroma of the crest of the right ilium. Dr. G. G. Davis saw the case in consultation and advised exploration, as the result of which there was found at the bottom of a very deep extraperitoneal dissection a torpedo-shaped mass of lime salts having a pin as its nucleus. The incision was drained and before the resulting sinus healed the patient left St. Joseph's Hospital. Several months later he was readmitted, this time to the service of Doctor Davis, who, operating for the closure of the sinus, found that it terminated in a perforated appendix, which he removed, with subsequent healing of the abdominal wall.

Dr. Charles H. Frazier said, at the risk of going too far afield into a discussion of foreign bodies found in the appendix, he would mention the case of a little girl upon whom he operated a good many years ago for appendicitis. Upon putting his finger through a small incision to take out the appendix he felt a pin prick. After having made the incision wider and, picking the appendix up with a pair of forceps, he saw a black rusty pin protruding half an inch beyond the lumen of the appendix. The child made an uneventful recovery. He referred also to the case of a well-known colored employe of the University who succumbed to pneumonia. The autopsy revealed a large rusty nail in the appendix.

Major Donald McCrae said that a number of years ago a case was brought to him as one of appendicitis and with the history of having had several attacks. He made the usual incision and found the appendix quite normal. Of course, the appendix was removed, but a little higher up he found quite a little mass, and in separating this there was seen a rather in-

flammatory adhesion between the cæcum and a loop of small intestine from which he evacuated a few drops of pus and in the centre of which was a tooth-pick. The tooth-pick had perforated the ascending colon, made its way into the loop of small intestine, and was in position to pass out the other side of the loop. It was pulled out through the second opening in the wall of the intestine. The opening was closed, a cigarette drain inserted, and the patient recovered. It struck him that there might be no end of the wanderings of this tooth-pick, having seen it actually passing through the cæcum into the small intestine and headed for the other side. Nature had shut off the other end. Having almost seen the process taking place he could imagine how such a body might under certain conditions wander about in many ways.

FIG. 1.—Dislocation forward of sixth cervical vertebra.

FIG. 2.—Dislocation reduced

CORRESPONDENCE

BILATERAL DISLOCATION OF THE SIXTH CERVICAL VERTEBRA FORWARDS

EDITOR ANNALS OF SURGERY:

Having noticed in a recent number of the ANNALS an article on dislocation of the spine, I am sending you two remarkable X-rays of a case treated by me.

The patient, a woman, thirty-two years of age, was knocked down by a Ford car November 12, 1915. I saw her late at night on November 13, in the Sisters' Hospital of Salina, Kansas, with Doctors McCullough, Riddell and Miers. She had a moderate sized goitre and had had bronchitis for ten days. There was no notable deformity of the spine, but there was much cervical pain. Motion of the head was possible but painful. The urine had been drawn off with catheter and the rectum evacuated by enema.

Right Lower Extremity.—Can raise knee off bed. Can move the toes.

Left Lower Extremity.—Can rotate but cannot flex or extend thigh. No motion in toes. Sensation to light and heavy touch and to prick present. No zone of hyperæsthesia. An X-ray by Doctor Brittain showed a forward bilateral dislocation of the sixth on the seventh cervical vertebra (see Fig. 1).

November 14, under chloroform by Doctor Harvey, direct traction with the hands on the head was exerted and one distinct "click" was felt and heard in the neck which suggested that reduction had been obtained. An X-ray, however, showed that nothing had been accomplished. Further repeated efforts at manual traction also failed to give results.

The head was then passed through the hole in a strong laparotomy sheet, which gave a perfect means of counterextension. By means of towels and bandages loosely placed around the neck, it was possible for two men to apply powerful traction to the head. When this was done, we were rewarded by hearing and with the palpating finger feeling two distinct "clicks" in the spine. An X-ray showed that complete reduction had been effected.

Eleven weeks after the accident the patient weighed 135 pounds, having lost 25, and could walk 15 or 20 feet without assistance. She suffered some pain in the neck, shoulders and chest, especially during bad weather. Her arms and hands were weak.

On October 29, 1916, her husband wrote: "A great many people think Mrs. H. looks as well now as before the accident, but she lacks a great deal of being well. She has been doing the work at home for some months past, which, with our two children, represents a good deal of work. She gets along nicely with it, but tires easily. She is troubled with stiffness through her hips and back after sitting still any length of time, also when getting up in the morning. This trouble seems worse in cold weather."

JOHN FAIRBAIRN BINNIE, M.D.
Kansas City, Mo.

January 5, 1918.

BOOK REVIEW

RECOLLECTIONS OF A NEW YORK SURGEON. By ARPAD G. GERSTER, M.D. 8vo, cloth, pp. 347. New York: Paul B. Hoeber.

The author has given us in this book a charming record of his life work. It might also have been entitled "The Making of an American Citizen," for it is as an Austrian Medical Officer, on the Reserve List, that Doctor Gerster first comes to the United States in 1873, and as an American Medical Officer on the Reserve List that he completes the record forty-four years later.

We thank Doctor Gerster for giving us this book. It is most instructive and illuminating, as well as entertaining. Arthur Christopher Benson has well said in his essay on Books: "Almost the only books which I think it is a duty to read are the lives of great contemporaries; one gets thus to have an idea of what is going on in the world, and to realize it from different points of view." The alcove devoted to Biography, therefore, is the most important element of any library. To the surgeon there is a wealth of such material at his hand and he makes a grievous mistake if he neglects it. In magnifying the biographies of our contemporaries there is no thought of consigning to oblivion the life records of the great worthies of the more distant past. These will never cease to be the guides and models of the student and practitioner, but they are more set apart and clothed with a sentiment that ranks them above common mortals; feelings which we do not have when we read the records of our own companions or personal teachers, whose hands we have grasped and whose foibles, as well as whose virtues, we know. With what zest have we read Gross' Autobiography; Marion Sims' Story of My Life; Vallery-Radot's Life of Pasteur; Sir James Paget's Memoirs; William Thompson Lusk's War Letters, or John A. Wyeth's "With Sabre and Scalpel."

The picture which Doctor Gerster draws of his birthplace, the Hungarian town of Kassa, is quite idyllic. The royal free city of Kassa seems to have been an ideal *imperium in imperio,* a small republic sufficient to itself in its happy valley in the interior of Hungary. Alas, that these rights should have vanished almost at the time of birth of the author! We read with interest the references to the turbulent times culminating in 1848. We can readily appreciate that the same spirit which prompted the father to become an insurgent in 1848, also prompted the son in later years to choose as the field for his life work the Western Republic.

Any man who has played an important part in the affairs of his generation can well serve his fellows by leaving behind him such records of his own experiences, motives and accomplishments. LEWIS S. PILCHER.

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